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An underground trolley-system, the invention of Malone Wheless, of Tennessee, is being tested on a ¾-mile section in Washington, D. C. Briefly described, the road is laid with 40-lb. T-rails, yokes of 180 lbs. each and 40-lb. slot-rails. The conduit, midway between the rails, is 16 ins. deep by 17 ins. wide, and inside is a loose wire on insulated brackets. This wire is cut in 200 ft. lengths, and only carries a current when the car is moving over one particular section. The copper feeding cable is laid parallel to the trolley-wire. Without going into details, the car is fitted with two ordinary 20-HP. motors, and a pair of trolley wheels passing through the slot connects the motors with the trolley-cable. In each 200 ft. section is an iron switch-box containing an electromagnet; and as the car enters a section a storage battery of several cells on the car vitalizes the magnet and lifts an iron armature and connects the trolley and the feed cables and thus supplies power to the motors, while the main line current cuts out the local battery. On reaching the next section the current is again automatically switched on and is also cut off from the rear section. When the car stops the current is instantly released from the trolley-wire, and the same is the case when going down hill. The car can travel in either direction by turning a reversing switch. The cost, for single-track, is said to be $30,000 per mile.

The South Buffalo, N. Y., dock project seems to be assuming shape, as the promoters claim that nearly the whole of the $3,000,000 of stock required is subscribed for. Messrs. F. G. and G. R. Sykes are the engineers mentioned in connection with the scheme.

The abolition of the second-class fare and accommodation on English railways is going steadily on. The latest to take this step is the Highland Railway, with 425 miles, making about the twelfth company which has made the change, and the third company which has made it during the current year.

The ground-plans for the new City Hall for New York are practically adopted, and include the removal of both the old City Hall and the later court house. Designs to be submitted should show about 70,000 sq. ft. of available space on each floor, and there will not be more than five stories in any part of the structure. Five equal premiums of $2,000 each are to be awarded to the authors of the five best designs. And if his professional standing warrants it, the author of the first prize is to be made supervising architect, with a commission amounting to 5% on the first million expended in total cost of work; 4% on the second, and 3% on the remainder. If his standing is not sufficient, the Building Commission may appoint an assistant architect, and the fee shall be divided.

The steel tower, 500 ft. high, at Blackpool, England, is being pushed toward completion, and about 1,100 tons of the total 2,200 tons of iron and steel are already erected. This tower is being erected by Maxwell & Tuke, of Manchester, and the scheme includes a fine block of buildings, from the center of which the tower will rise. Mr. Max am Ende is the consulting engineer. The space between the tower legs will be used as a circus; and the ceiling of this circus forms the floor of the elevator hall, 55 ft. above the ground level.

Two saloon cars for the use of families or invalids have recently been built by the Southeastern Ry., England. The cars are 33 ft. long, with a main saloon 18 ft. long, seating ten persons, and a separate compartment seating six persons. There are also a baggage compartment and a lavatory. For use of invalids, one of the lounges of the saloon is removed, and a couch suspended from the roof by slings, and secured by springs and elastic fittings, to reduce the vibration. The interior finish is very elaborate. The cars are lighted with gas, and fitted with mechanical ventilating apparatus, as usual on modern English cars.

The most serious railway accident of the week was a head collision April 4 between a freight and accommodation train on the Jacksonville Southeastern R. R., near Glen Vernon, Ill. The cause was due to carelessness in disregarding new orders. There were 4 men killed and 6 injured.——By the derailment of a passenger train on the Denver & Rio Grande R. R., near its crossing of the Colorado Midland R. R. at Leadville, Colo., on March 31, about 18 persons were injured, some seriously. The train consisted of 6 sleeping cars, 1 day car, 1 smoking car and 2 baggage cars, 10 cars in all, of which all but the front baggage car left the track, the four rear sleeping cars going down the bank.

A trestle failure near Jug Tavern, Ga., on the Gainesville, Jefferson & Southern R. R., is reported. The trestle is said to have been a double-deck structure 350 ft. long, 50 ft. high, crossing Marberry Creek, and to have been built about nine years ago. It gave way March 31 under a mixed train of 6 loaded freight cars and 2 passenger cars, all of which with the tender went down, leaving only the engine on the track. One man was killed and about eight were injured.

A cave-in occurred at the works for the east side trunk sewer of Rochester, N. Y., on April 1, when 20 ft. of section 6 fell in where the sewer passes in tunnel diagonally under the canal near Lock No. 6. The contractors were V. G. Voltz and M. A. Weider. The excavations on both sides of the canal were about completed and preparations were being made to brick the portion under the canal, where the depth of the floor of the sewer is about 25 ft. The tunnel is 8 ft. diameter. All the excavating on the south side of the canal has been done since the ground has been frozen. The roof was shored up by 6×6 in. oak timbers. When the masons came to work a large crevice was noticed in the bank at the canal and the men did not go to work in the tunnel. Mr. Voltz arrived and after examining the bank pronounced it safe. Mr. Wieder, who had been superintending the night work on Main St., came up and after a brief consultation the men entered the sewer, followed by several of the stone masons, who were engaged in flooring the tunnel. The party had proceeded about 30 ft. when a cracking was heard, and one of the timbers overhead gave away. The laborers escaped in safety, but Mr. Voltz, who had led the way, was buried beneath the ruins and killed. Mr. Weider, who had walked close behind him, managed to escape, although he sustained painful injuries from the mass of earth that fell upon his head and shoulders. The roof timbers are said to have been too far apart, and Mr. Peacock, who is in charge of the construction of the sewer, stated that in his opinion the contractors had not used enough planking and sheathing to hold up the mass of rock and earth.

A 36-in. Venturi water meter has been built by the Builders' Iron Foundry, Providence, R. I., under the patents of Mr. Clemens Herschel, N. Y., for the World's Columbian Exposition. This meter will be placed in the extreme southeast corner of the grounds, and will measure the entire water supply of the Exposition, about 24,000,000 gallons a day. The recording apparatus will be exhibited in the adjacent building of the sewage purification works.

Proposals for the construction of a four-track iron viaduct along Park Ave., New York, between 110th St. and the Harlem River, will be received by the Board for Park Ave. Improvement, 132 Park Ave., until April 26. This viaduct is to carry the New York Central & Hudson River R. R., at an elevation above its present tracks, along the avenue to the high-level drawbridge over the Harlem River, the present masonry viaduct and depressed road being done away with. The plans have been prepared by Mr. Walter Katte, Chief Engineer, and Mr. George H. Thomson, Bridge Engineer, of the New York Central & Hudson River R. R. The viaduct will be a four-track structure, with longitudinal plate girders, a solid steel trough floor of the type largely used by Mr. Thomson for bridges on this road, and columns built up of angles and lattice bars. Open-hearth steel is to be used, with not more than .08% phosphorus, .06 sulphur and .40 manganese. The rails will be of 100-lb. section, (Eng. News, March 19, 1892), with metal tie plates, resting directly on the tops of the troughs. In order to deaden the vibration and noise, it is proposed to fill the troughs with some sound-deadening material, and experiments will be made with mineral wool, cork chips and other substances, made into the form of a cement. Work is to be commenced by Sept. 1, 1893, and completed by March 1, 1894. Mr. Katte is Superintending Engineer for the Board.

Four plate girders, each 123 ft. long, 9½ ft. high and weighing 46 tons, were recently transported by rail from the builders, the Elmira Bridge Co., to Wallingford Junction, on the New York Central R. R. Four platform cars were allotted to each girder; the weight of the truss being carried on the two end cars only upon wooden platforms with side bracing to the girder. On curves the girder was free to slip on the three cross-timbers provided, the struts being secured over the top of the girder by a strap. As shipped the top of the girder was 14 ft. 9 ins. above the rail.

A Roman road, near Moffat, in Scotland, has been closely examined by Mr. G. T. Johnstone, and described. The road was 21 ft. wide, with a whinstone curb on each side. Exclusive of the turf covering it was 23 ins. deep from foundation to crown. The foundation was a layer of clay, 6 ins. deep in the center, and tapering to the sides, with undressed stone bedded from 1 to 1½ ins., into the surface of the clay. Then came a layer of stones, 11 ins. deep, about equal in size to a boy's head, and with the vacancies filled with "till." A 4-in. layer of smaller stones formed the top surface of the road. At another place the clay and stones were mixed together like concrete in a bottom layer, 11 ins. thick, with the 4-in. smaller stone layer above.

A coating of peroxide of lead, applied electrolytically, is recommended by German authority as a protective against rust in iron or steel structures. A satisfactory coating can be obtained in 20 minutes; and, as the whole operation is conducted at an ordinary temperature, the temper of steel articles remains unaffected.

A new explosive is reported from Germany, which has been tested by a commission of artillery experts as a material for replacing gunpowder in the German army. The Berlin dispatches describe it as a brown, fatty substance, of the consistency of frozen oil, under ordinary temperatures, and up to 112° F. A shock or a spark does not explode it, contact with a special chemical compound being required for this purpose. The explosion is accompanied by hardly any smoke, and an inconsiderable detonation and little recoil. The composition is kept secret.

The average daily water consumption in Philadelphia for 1892 was 163,801,600 gallons, or about 160 gallons daily per head of population. Mayor Stuart, in his message, says that the pumping capacity will be increased this year by the addition of a 20,000,000-gallon pump at the Spring Garden station, a 15,000,000-gallon pump at Frankford station and one 12,000,000-gallon pump at Roxborough. A new reservoir at Queen Lane is to be built at a cost of $1,159,591.

The promoters of the Chicago & St. Louis Electric R. R., no longer claim that their proposed 100 miles an-hour line will be ready for business before the close of the World's Fair. The contract with Messrs. Garvey Bros., of Memphis, and Bagnall Bros., of St. Louis, call for the completion of the grading within a year, at a cost of $5,500,000, and it has been stated that active work on the line was to begin during the current week. So far, however, no news reaches us of the collection of any extensive army of graders on the line of the road.

The Italian State Railways, says the "Nuova Antolcgia," paid about 1.63% on an investment of 4,000 millions of francs in 1892, and there is a steady tendency toward a decrease in profits under state management. In 1860, with a capital account of 545,900,000 francs, the profits were 3.57%; but with a steady increase in capital the profits have steadily diminished ever since to the figures given. In 1860, with 1,666 kilomsof railway, or about 1,033 miles, the working expenses of the lines amounted to 53%; this item, too, has increased each year until in 1892, with 8,506 miles of railway, the working expenses figure at 70.4%. In the period 1860-1892 the receipts per kilometer have fallen from 24,900 francs to 18,400 francs, while the net profits have fallen in the same time from 11,700 to 5,400 francs per kilometer.

ELIMINATION OF A DANGEROUS TRACK CROSSING ON THE PENNSYLVANIA R. R.

The Pennsylvania R. R. is making very extensive improvements to its line, in the way of reducing grades and curves and eliminating track crossings at grade. A dangerous place at Philadelphia was at the West Philadelphia yard, which had to be crossed by all main line trains on the New York Division, but which has now been eliminated.

The accompanying cut, reproduced from a photograph, shows the Thirty-sixth St. Tunnel, at West-Philadelphia, which was opened for service in September, 1892, to enable the passenger trains of the New York Division to reach Philadelphia without crossing the West Philadelphia yard at grade, as they formerly did. There are two passenger tracks through the tunnel and 1 passenger and 7 freight tracks over the top. It is a classification yard that is worked by gravity, and this work was done without interfering with the passage of any trains. The tunnel is 476 ft. long. The eastbound trains on the Philadelphia Division pass on one side of the approach, and the westbound trains pass over the tunnel on the other side, avoiding all grade crossings entirely. It will be seen that the work is very substantial and up to the Pennsylvania R. R. standard. It was carried out under the supervision of Mr. Wm. H. Brown, M. Am. Soc. C. E., Chief Engineer of the Pennsylvania R. R.

ELIMINATION OF A DANGEROUS CROSSING ON THE PENNSYLVANIA R. R. AT PHILADELPHIA, PA.

A Connelly naphtha gas motor has for the past two months hauled a portion of the traffic on the London & Greenwich tramway, England. From a return of seven days' working, 14 hours a day, it appears that 350 trips were made, covering 507.85 miles, and carrying 4,182 passengers, with a total consumption of 70 gallons of oil.

EXPERIENCE WITH ELECTRICAL SUBWAYS IN NEW YORK CITY.

As our readers know, a great amount of work has been done in New York city during the past decade in putting electric wires underground, and it has been done in the face of repeated prophesies that underground circuits could not be successfully operated or maintained. In view of the steadily increasing demand for the removal of overhead wires, not only in the large cities, but in those of moderate size, the results of the work done in New York are of much interest.

The best statement of the results obtained from the electric subways of New York city which has been made public is that given in papers by Mr. Wm. Maver, Jr., Electrician of the Consolidated Telegraph & Electrical Subway Co., read before the Institute of Electrical Engineers and contributed to the "Electrical Engineer." A paper on this subject was also read at the recent meeting of the National Electric Light Association by Mr. Wm. H. Browne. From these sources the following article has been prepared. The methods adopted in the construction of the subways were described in our issues of April 21 and May 5, 19 and 26, 1888. There are now in New York city 287 miles of electrical subways. Of this total, 172 miles belongs to the Edison Electric Illuminating Co.'s low tension system, over which a direct current of about 75 volts is transmitted; 45 miles is for the use of telegraph, telephone and district messenger companies, and the remaining 72 miles is devoted to high-tension electric wires. The Edison system differs materially from the others, as the wires cannot be removed except by digging them up. The copper wires are wound with rope and placed in an iron pipe which is then filled with an insulating compound, comprised of Trinidad asphalt, rosin, paraffin and linseed oil. This work is done at the factory. Each pipe contains three conductors, the Edison plant being nearly all operated on the three-wire system. The pipe is made in 20-ft. lengths, and is simply buried in the trenches, which are usually made made rather shallow, and are frequently placed directly over the other subways. The 20-ft. lengths are connected by "coupling boxes," as the pipe is laid. All the wires of the Edison Co. have been laid underground in this manner since the company began operations in 1882. While this system accommodates satisfactorily the wires of a single company, the other class of subways have to furnish accommodations for a number of different companies (6 telegraph and telephone companies and 6 electric lighting companies are now using them), and they are so arranged that wires, or rather cables, may be drawn in and out without disturbing the subways themselves.

As stated above, the several systems of subway construction which have been tried in New York city have already been described in this journal. The fact of greatest interest concerning them is that the simplest form tried, consisting merely of iron pipe surrounded by concrete (1 Rosendale cement to 3 sand), has been as successful as any, and nine-tenths of the subways now laid are of this class. It is of some interest, however, to note the defects which caused the abandonment of the more complicated forms of subways. The Dorsett system, described at length in our issue of Sept. 11, 1886, consisted of asphalt blocks, 4 ft. long and 1 ft square, with tubular openings, about 2½ ins. in diameter, from end to end. These blocks were placed end to end in the trench with a small sleeve in each duct, at the junction of the blocks, and melted pitch and tar was poured into the joint to make the two blocks continuous. About a mile of this

conduit on Sixth Ave., containing 16 ducts, was laid in 1887, and has been used for telephone and telegraph conductors. It is in a fair state of preservation, but not perfect, some of the blocks having sunk and disturbed the alinement of the conduit. Of course, this conduit was more expensive than the simple iron pipes laid in concrete, and as it proved to be much more difficult of construction and more subject to deterioration, no more has been laid.

In Fifty-eighth St. some zinc tube conduits were laid. The zinc tubes were very light, and were intended merely to serve as a mold for the concrete around them, it being expected that the zinc would soon corrode and leave the duct in the concrete intact. It was naturally found, however, that a frail zinc tube was liable to be bent or crushed in the process of packing concrete around it, and this type of conduit was abandoned.

Cement-lined sheet iron pipe has been used more extensively in New York than any other form of subway, except the wrought iron and concrete form. The sheet iron pipe is laid vertically, and a brass tube is placed inside it. Into the annular space between the two cement grout is poured. When the cement sets the brass tube is withdrawn.

About 15 miles of creosoted wooden ducts, made of wooden piping, similar to pump logs, have been laid and used for lead covered telephone cables, the lead being alloyed with about 3% of tin. No deterioration has been noticed in the lead covering of these cables, although in other cities the lead covering of cables laid in creosoted wood has rapidly corroded.

This matter, however, is of comparatively little importance in view of the success of the wrought iron pipe subway. The reason why wood, asphalt and other substances were looked on with such favor in the early days of electrical subways, was the general feeling that the subway must be itself an insulator. Comparatively little had then been done in the insulation of wires and cables, except for submarine cable work. Bare wires, or wires insulated only with a fragile cotton covering, were in general use. But with a thoroughly insulated cable, it makes little difference whether the duct in which it lies is insulated or not. In fact, some advantages have been found in operating high-tension electric currents in subways from the fact that the lead coating of the wire is practically grounded for its whole length. It is thus impossible for a man handling these wires in the manhole to receive a shock, for the lead covering in contact with the iron pipe for its whole length furnishes an easier path to ground for the current than does the man's body. Again, in testing a cable laid in a conduit of wood or asphalt, there might be a break in the insulation of the cable and yet the test would not show it. With the cable laid in an iron pipe, however, any break in the insulation will appear in the test.

As evidence of the safety of the wires in the subways, workmen in the manholes handle live wires by means of the lead covering without the slightest indication that they are alive. In experience of some half-dozen years there have been no accidents whatever from the operation of the electric wire subways; yet the average potential of the arc light circuits in the subways is 2,000 volts, and in some cases it reaches 3,500 volts.

Before these subways were undertaken, strong arguments were presented to prove that trouble from induction and leakage would make the operation of underground wires wholly impracticable. The results have proved that these expert prophets were wrong. The telephone service was impaired somewhat, so long as ground return circuits were used; but since the metallic circuits were adopted the service is satisfactory. On long distance telephone circuits the loss of efficiency on seven miles of cable is, however, somewhat detrimental. As a general rule, the subways for the telegraph and telephone wires are placed on the opposite side of the street from the high-tension electric lighting subways. In a few cases, however, both subways are on the same side of the street, and no trouble is found from their proximity.

As stated above, the total extent of the high-tension electric light subways is now about 70 miles, and of the telegraph and telephone subways about 45 miles. The total mileage of ducts in the first class of subways is about 600 miles, and there are about 700 miles of ducts in the telegraph and telephone subways. The ducts being 2 to 4 ins. in diameter, each duct may contain a half-dozen or more cables. In the electric light circuits each cable contains one wire only; but each cable of the telegraph and telephone companies contains 50 or more separate conductors.

The total capacity of the subways now laid is about 45,000 miles of telegraph and telephone wires, and 5,000 miles of high potential electric lighting wires. There are now in the subways about 23,000 miles of telegraph and telephone circuits, and about 600 miles of arc and alternating current conductors, some 320 miles of the former and 280 miles of the latter. The arc light conductors supply current to about 5,000 arc lamps, averaging about 60 lights on a circuit and 15 lights per mile of cable. The alternating current conductors are arranged in 50 circuits, and supply 90,000 incandescent lamps, or an average of 1,800 lights per circuit and 320 lights per mile of cable.

Besides the 600 miles of main cable, there is about 150 miles of cable in the subsidiary ducts reaching from the subways to the premises of private consumers. In these 750 miles of electric lighting cables in 1892 there were developed faults of all kinds, to the number of 49; 11 were "low tests," that is, the insulation resistance was not up to the standard specified by the subway commission. Of these, 8 were found to be due to bad joints or to defects in the terminals. The cause of the other three was not determined; 24 "grounds" were discovered during the year. Of these 16 were found to be due to bad joints or defects in the terminals, 4 were due to mechanical injury to the cables, and the cause of 4 was not ascertained. The remaining faults consisted of 14 "burn-outs," 6 of which were caused by mechanical injury to the cable and 7 were due to bad joints. Mr. Brown commented on these as follows in his paper:

> Two "low tests" and nine "grounds" due to terminals cannot be considered as faults in the cables proper. Of the 38 faults discovered in the cables, 18 were due to bad joints, 10 to mechanical injuries, and 10 to causes unknown; but probably mechanical injury.
>
> The 38 faults of the cables occurred on 25 circuits, so that 106 circuits were operated throughout the entire year without a fault or trouble of any kind. Two of the 25 circuits were each responsible for five of the faults, one having four "burn-outs" and one "ground," the other four "grounds" and one "low test."
>
> It may be said here that the troubles from bad joints occurred usually at the beginning of the use of the circuit, and the same may be said to a large extent of the troubles with the terminals. This can be avoided by careful work.
>
> The nine "burn-outs," eight "grounds" and three "low tests" due to mechanical injuries or causes unascertained may be considered as the dangers which cannot be guarded against in a system where cables of several companies are in the same manhole to which employees of each have access, but the experience of nearly four years indicates that this source of trouble is decreasing.

Doubtless the practical success of the New York subways is in some measure due to the high insulation of the conductors (5 megohms per mile per 100 volts potential employed), which was required by the Board of Electrical Control. Strenuous objections were at first made to this requirement by some of the companies, and the claim was made that it was too high to be practical. Experience has amply shown, however, that cables can readily be made to fulfill all requirements, and at a cost which is by no means prohibitory. In fact, we are so far past the "bare wire" age in electrical conductors, that it now generally recognized that good and thorough insulation of a conductor at the start is the cheapest practice in the long run.

Of the troubles which have been met and conquered in the operation of the subways, gas explosions and heat from the steam pipes of the New York Steam Co. have been the most important. The latter trouble was experienced in the lower part of the city as soon as the subways were put in use; it was confined to a few local points, but here the temperature in the subways rose at times as high as 200°. Of course, this was rather threatening to the insulation on the subway cables. The leaks in the steam pipes were stopped, and the course of some of them was changed, so that they were not as close to the subways, and there is now no trouble from this source. It may be noted as showing the excellent insulation of the cables in the subways that even at the high temperature of 200° the rubber insulated cables successfully met the requirements as to insulation resistance.

The gas explosions in the subways, which occurred in 1887-9, caused much anxiety among the subway engineers, and really threatened the existence of the subways until a means was devised of absolutely preventing them. It was clear that the citizens would not long endure the existence of a magazine of explosive energy underneath every street, liable to blow up at any time, and transform the manhole cover at each corner into a death-dealing projectile. From May 9, 1887, to March 25, 1889, there were twelve explosions in the subways, and the public excitement concerning them will be well remembered.

A great deal of theorizing was done concerning the cause of these explosions; but the cause was no mysterious one. The soil of every New York city street (it might almost be said of any city street) is more or less permeated with gas, the principal source of which is the leaky mains of the illuminating gas companies. In the soil this gas is probably under a pressure slightly above atmospheric, at any rate one's nostrils testify that it escapes in profusion when the soil is exposed to the air. The subways are not absolutely air tight, and so the gas slowly percolates into them, and they gradually fill with a mixture of gas and air.

The problem of ventilating the subways, or, more properly, of maintaining such a pressure in them that gas would not leak in, was entrusted to Mr. Wm. J. Baldwin, M. Am. Soc. M. E., and under his direction twelve blower stations were established at convenient points along the subways. The blowers used are of the Root pattern, with capacities varying from 1,200 to 4,200 cu. ft. per minute against pressures of 3 oz. to 16 oz. per sq. in. The estimates on which the system was proportioned were:

Leakage from manhole, cu. ft. per hour	500
" per mile from cast-iron ducts, cu. ft. per hr.	1,000
" " from wrought-iron ducts cu. ft. per hr	disregarded.

As there are about 24 manholes per mile, the air required per mile of subway with wrought iron ducts will be about 12,000 cu. ft. per hour, and about double this quantity where cast iron ducts are used. Each blower station supplies air to the subways for about a mile each side of it, and could supply air to twice as great a distance each way if necessary. To distribute air from the blower station to each subway manhole, a 6-in. wrought iron pipe is laid above the subway, passing directly through the manholes. The blowers deliver into these pipes and the air escapes from these pipes into the manholes through graduated openings which may be not more than 1/8 in. close to the blower station, where the pressure is high, and a mile away, where the pressure is low, may be as much as 3/4 in. in size. Where steam was available without the erection of a separate boiler and the employment of a special engineer, steam engines are used to drive the blowers. At other places Otto gas engines are installed, and require so little attention that one engineer attends to five of them, visiting the various stations in rotation. The total horse power of all the blowers, measured in work actually done upon the air, is 69.056 HP., so that probably about 100 HP. is actually absorbed in the work, or something less than 1 HP. per mile of subway.

Perhaps the most difficult point which has troubled the subway engineers has been the method of getting the wires from the subways to the premises of the consumer. Several different systems for effecting this have been used. The telegraph and telephone companies generally take out at the manholes the wires to supply their customers on the adjacent block, and lead them by a subsidiary conduit to the front of the buildings. They are then taken to the roofs or to the rear of the buildings and radiated to the points desired. To distribute the electric light current to the lamps on the street corners, a loop is made from the manhole to the lamp post through a subsidiary iron pipe. To reach houses and lamps in the middle of the block, the Johnstone sectional conduit has been largely employed. This consists of sections of cast iron ducts about 5 ft. in length, with "handholes" opposite every house or alternate house. The conduit is laid directly in the earth, not in cement, and close to the surface. To obtain access to a conductor to tap or loop a circuit, the paving and earth are removed, and the cover of the handhole is lifted. The conductor is led to the vault or basement of the house through a 3-in. iron pipe.

A similar, but simpler, method of distribution has been employed, in which iron boxes, about 18 ins. square, with covers, are placed every 50 ft. and

connected by three or four wrought iron pipes laid in the earth near the surface. At first the boxes were covered by the paving, which had to be removed to get at the wires. To obviate this, the height of the box was increased, and the cover was brought up flush with the paving. Trouble was then experienced with the box filling with water in heavy rains, and deposits of mud would be left as the water drained off. This was met by making the box like a miniature shallow manhole, with brick walls and a double cover, arranged to shed water and dispose by a blind drain of any which might leak in.

Injuries to the electrical subways since they have been in service have been remarkably small. The hydraulic concrete in which the pipes are laid, and which is made quite thick on the top and bottom, is of course, a protection to the pipes, and, in addition a 2-in. creosoted plank is laid on top of the concrete. Only one case is on record where a street excavator's pick has broken into a duct. Parts of the subway have at times been flooded, through the breakage of an adjacent water main; but the excellent insulation of the cables has prevented any interruption of a circuit from this cause. The water has drained off and no harm has resulted. Before the cables were placed in the subways some apprehension was felt as to the effects of lightning on the cables. Lightning arresters were placed on some of the circuits as a precautionary measure, but others were unguarded, and there has not been thus far a single instance of injury to the underground circuits by lightning.

It was also apprehended that some trouble might be experienced in operating the alternating current circuits underground; but by placing both wires of the circuit in one duct, trouble from increased self-induction is avoided. In fact, the only practical difference in the operation of overhead and underground circuits observable is that the underground circuits operate decidedly better during wet, stormy weather, and that when the wires are underground the superintendent of the station "can go home and sleep nights"; in which remark, to the initiated, there is a wealth of meaning.

According to Mr. Browne's paper, experience has shown that in building the subways the requirements of the electric lighting companies were rather over than under-estimated. Of the 600 miles of ducts built, only about 260 miles has been rented by the companies, and 50 miles of this is not yet occupied with cables. Broadway has 200 miles of ducts, of which but 80 miles are occupied. Profiting by experience, in the subways more recently constructed a smaller number of ducts has been laid. In 1892, for example, 10½ miles of subway were built containing 24 miles of ducts. Thus, most of the subway built consisted of only two ducts.

It is evident that the cost of the subways is materially increased by the fact that competing companies have to be provided for in them. Thus, the total wires necessary to supply a street may all be accommodated in one duct, whereas two at least will have to be provided if there is to be any competition at all. At present a half-dozen electric lighting companies and as many telegraph and telephone companies have wires in the subways, and there are points on certain streets at which circuits belonging to every one of these companies pass. In a city where the whole business was in the hands of a single company the problem of subway construction would be much simplified, and the expenses would be much reduced. We have discussed further this important question in our editorial columns.

In concluding his paper before the Institute of Electrical Engineers. Mr. Maver presented the following general statements as fully warranted by the experience of the last half dozen years in New York city.

(1) It is possible to successfully operate all classes of electric conductors underground in cities. (2) It is advisable to set the standard of insulation high, at least for conductors conveying high-tension currents. (3) Regular insulation tests of the conductors are very valuable. (4) Liberal thickness of insulation is desirable for high-tension currents. (5) It is unadvisable to place underground new types of cable or insulation until they have been subject to tests and conditions analogous to those to which they will be subjected underground. (6) For electric light conductors, especially distributing mains, many conductors under one cover are not advisable, owing chiefly to the difficulty of making joints in such cables. (7) All sharp edges in ducts should be avoided. (8) Until the gas companies are required like the electric light companies to maintain their mains in a fairly sound condition, a means of ventilating the subways should be provided simultaneously with their construction. (9) Constant expert attention to details, and thorough organization in every department, are essential to the production of a successful electrical underground system.

THE FREE PORT OF COPENHAGEN.

We are indebted for the material which here follows to Mr. P. Vedel, C. E., for a number of years connected with the free port of Copenhagen as an engineer, and still holding that position. Mr. Vedel has made a careful and lengthy study of the seaports of South America, Germany, England, Holland and France, and is now in the United States on a similar errand.

In the preface to the communication sent us Mr. Vedel freely expresses his views upon the tariff question, and is decidedly opposed to protection as usually practiced. He refers to the bonded transit of dutiable goods after the method practiced in this country, and speaks of the Danish "credited storage" system as an alternative to the "drawback" system. This storage plan originated in 1793, and has been further developed by the laws of 1864. It allows the merchant to receive and store imported goods in his own warehouse, under lock and key, without paying the import dues; if exported again they are written off in the house accounts; if he sells them he pays the duties quarterly. The weak point of this system, as compared with a direct import duty, is that the waste, breakage, etc., amounts to a heavy tax on the trade. By storing his goods in special transit storage stores, free stores, custom house stores or bonded warehouses the merchant is relieved from the burdens mentioned; these being under the more or less close control of the custom house officers.

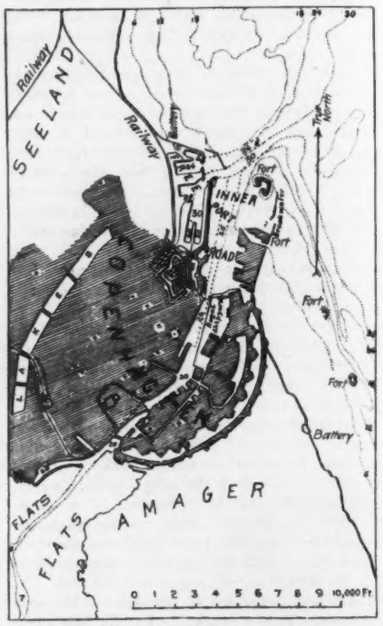
Shipping is also subjected to many harassing delays and inconveniences by the enforcement of regulations necessary for the proper collection of duties. The ships are boarded, sealed and watched from the time they enter the harbor or docks to their departure. When only a part of their cargo is to be unloaded, when the ship enters port for some other purpose than discharge of cargo, or when the goods are in transit only and must be stored temporarily in a warehouse until shipped again, the inconveniences arising from the imposition of duties are keenly felt by the captains and owners of these ships. Free docks were instituted to remedy this evil. Free ports were suggested for the benefit of manufacturers who use dutiable raw materials, machinery, fuel, etc., and yet wish to compete with other countries in the sale of exported goods.

In the proper sense of that word only a few free ports exist in the world. The two Austrian towns of Trieste and Fiume, after existing as a free ports for 200 years were deprived of that privilege on July 1, 1891. At the present time Hamburg and Bremen, on the North Sea, are the only free ports in Europe. On this side of the Atlantic there is an analagous institution in Mexico; that is, the "Zona libre," or a strip of land along the frontier of the United States, extending from Matamoras, on the Gulf, to the Pacific Ocean. All articles entering this zone pay 3% of the usual duty on entry, when destined for use in the zone. If exported to other parts of Mexico the remaining 97% of the duty must be paid. Free docks, or dock entrepots, are to be found in several places. London and Liverpool have free docks, and Antwerp, Marseilles and other seaports have their entrepots. The new port of La Plata, in the Argentine Republic, is to be declared a free dock.

The essential difference between a free dock and a free port is the greater extent of the latter, permitting the establishment of industrial enterprises. The free dock is purely commercial; the free port is a commercial and industrial institution. Both are thoroughly and securely inclosed, and inside these boundaries no duties are levied, and the officers of the customs have no authority whatever. In fact, the inclosure may be regarded as foreign territory. No duties are imposed, and no state or municipal tax is laid upon buildings, manufactures or professions; but all other taxes and tolls are levied as usual; that is, income tax on persons carrying on business within the inclosure and living outside; charges for warehousing or dock and tonnage dues, light dues, buoy and beacon dues and other imposts upon shipping. All goods passing from the free territory into the country are liable to the same import dues as if coming from abroad. As a rule, only the officers and workmen necessary to guard the grounds are permitted to reside within the inclosure; and all articles used by them, or consumed during the daytime by persons employed in the territory, are treated as goods imported into the country.

A free dock, on the other hand, contains only sheds and warehouses, but no factories. The imported goods are stored, and no duty is paid until they are exported again or sent into the country for consumption. But during their storage they need not be kept in the original packages. They may be handled and treated in various ways; and are often unpacked, sampled and sorted; dealt out in small portions and repacked for retail trade; or various qualities of goods are mixed and prepared as demanded by local taste. Coffee may be given its color and wine may be adulterated with the requisite amount of spirits, sugar or water. Merchandise is also manipulated so as modify the application of the tariff to it. Thus, the duty on the casing may be saved by unpacking in the dock; the different parts of watches imported separately and then put together again after entry, etc.

In Bremen and Bremenhaven, both free ports, though ground is set aside for this purpose, no factories of any importance are yet established. In Hamburg, however, several industrial establish-



Map of Copenhagen, Showing the Port.

ments are located within the territory. The principal industries are shipbuilding, foundries and machine works, copper works, the production of artificial manure in connection with the roasting of copper ore, candle making, the rectification of spirits, the manufacture of colors, the manufacture of lubricating oil made from Russian naphtha, the making of oil cakes, a rice mill, etc. The privilege of establishing free ports at Hamburg and Bremen was granted to these cities when they entered the German Zollverein, and as an indemnity for renouncing their former rights as free Hanseatic towns. Other towns on the Baltic have lately applied for similar privileges.

In 1887, Germany began the gigantic work of connecting the Baltic and the North Sea by a canal extending from Holtenau, near Kiel, to St. Margarethen, on the Elbe. This canal is to be opened in 1895, and Copenhagen, with its unequal position on the Sound, soon saw the commercial danger that would result from the diversion of Baltic shipping from its old route around the Skaw. At the present time shipping to the extent of 16,500,000 tons annually passes through the Sound; and the Germans confidently hope to divert 11,500,000 tons of this trade into and through the canal. But of this estimate Danish engineers say that the canal

dues must be considered, and the further fact that the dangers of approaching the canal may be as great as those encountered in doubling the Skaw. They think, too, that the saving of time by the shorter canal route will be, to a considerable extent, counteracted by the reduced speed and the stoppages at locks and passing points. Copenhagen now hopes, by building a new harbor, provided with all modern appliances, and by declaring it a free port, to endure the competition of the canal and to retain, or even increase its commerce.

According to the latest figures, the annual entries and clearances of ships at Copenhagen amount to 5,500,000 tons register. The total length of quays is about ten miles, and the extensions now under construction will increase this about three miles, sufficient to accommodate about 2,500,000 tons. The free port bill was pushed through the Chambers in the session of 1889-90, and made a law on March 31, 1891. All plans having been previously carefully digested and prepared, work was immendiately commenced upon the walls, wharfing, breakwaters, etc., under the contract of the Harbor Board, with government supervision. But the management of the port and the construction of its sheds, warehouses and other buildings, except factories, and the installation of cranes, electric light, machinery, railways, etc., was intrusted to a private company with a capital of $1,100,000, furnished by the principal banks. This company is to issue dock warrants for goods stored, and impose a tariff for warehousing as approved by the government.

The estimated cost of the total work is about $4,900,000. Including work done previously, the share of the Harbor Board amounts to $3,800,000. The net proceeds of the working of the port are to be apportioned between the Harbor Board and the company, but the law provides for the abolition of dock dues, both in the old and the new harbor, as soon as the free port is formally opened.

The accompanying diagrams show the relative positions of the free port and the old harbor of Copenhagen and, on a larger scale, the general arrangement of the free port itself. In the Sound, as in the Baltic Sea, there is practically no tide; the only variations in water level are caused by the wind, but this may be as much as 4 ft. below and 4 ft. above mean water level. No locks are consequently necessary to retain the water in the harbor, and access is unimpeded at all times.

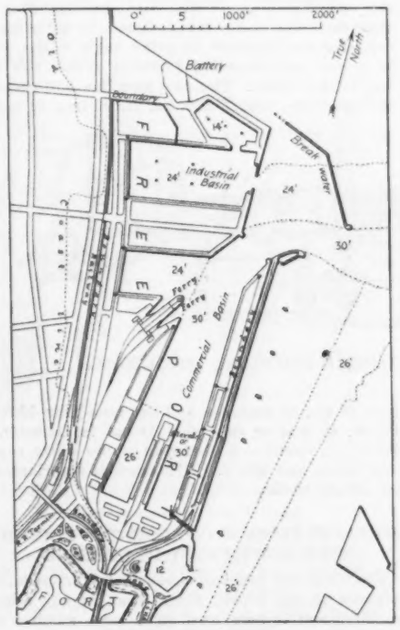
The present harbor of Copenhagen is formed by a narrow sound between Seeland and the small island of Amager. It divides Copenhagen into two parts, and its depth throughout is 20 ft. But the northern end and the channel to that end, which are dredged through with inner roads, have recently been deepened to 26 ft. The southern channel, through the great flats south of the city, has only 6 ft. of water, but is being deepened to 12 ft.

The free port lies to the north of the old harbor and to the west of the inner roads. Its water area is about 57 acres, and about 95 acres of land are included in its territory. It consists of two separate basins; the northern, or industial basin, is 1,300 × 620 ft., and has 24 ft. of water. A portion of its north quay is not comprised in the free territory, and this is also the case with the adjoining little basin of 4 acres with 14 ft. of water. The southern, or commercial basin, is divided into two branches. One, running west to east, is 460 ft. wide, and 515 to 980 ft. long, with 24 ft. of water. The other runs south to north, and is 800 ft. wide at its inner end and is divided into two compartments by a projecting pier of 1,030 × 185 ft. Its length is 2,650 ft., and the depth of water is 30 ft., except in the western compartment, where it is 26 ft. Between the two branches the Railway Board is to build a pier and berths for a steam ferry to be used in carrying trains and passengers across the Sound to Sweden.

South of the free port, and in the customs territory, is a small dock for pleasure craft, with an area of 3½ acres, and depth of 12 ft. West of the free port, along its western boundary, is a railway, connecting with the general railway system of the country, the terminus for goods, and the several railways of the free territory and the steam ferries. The old harbor is connected with the free port by a special railway and a carriage road fenced off and belonging to this territory.

The grounds surrounding the northern basin are set aside for industrial purposes; but sheds and warehouse for the trade proper will line the quays of the southern basin. The entrance to the industrial basin is 134 ft. wide, and to the commercial basin, on account of steam ferries, a 300-ft. width is given. Both are protected by a breakwater, and breakwaters protect the inner roads. A 30-ft. channel is to be dredged out to deep water, and a little harbor will be formed for tugs and pilot boats at the end of the eastern pier. A narrow canal, partly bridged over, will also be formed at the south end of the same pier to refresh the water in the basin and to provide a short cut for barges of little free board. A wire-net fence forms the boundary of the free port, and this is carried along the eastern pier so as to include its outside quay in the customs territory. Outside of this fence, and possibly on the roof of an 800-ft. shed, a promenade will form a continuation of the present "Long Line," a fashionable and picturesque walk.

The whole area comprised within the free port was formerly under water, the old coast line being shown on the plan. The ground has now been raised 6 to 7 ft. above mean tide, around the northern and southern basins, by dredged materials from the basins and channels. The southern basin is now being excavated, having previously been bulkheaded off and pumped dry by four centrifugal pumps of a total capacity of 10,000 gallons per minute, lifted 40 ft. The contract requires the removal of about 655,000 cu. yds. of clay and sand



Plan of Proposed Free Port at Copenhagen.

at $0.25 per yard; work is to be completed in summer of 1893. The northern section requires the removal of about 770,000 cu. yds. at $0.23 per yard. The price of unskilled labor is only $0.67 to $0.83 per day. The quays are being built as the earthwork proceeds. In the industrial basin and on the outside of the eastern pier the quay walls will be made of timber; in the commercial basin some of the walls will be made of timber and others built with granite on piles; others again will be made of concrete with a facing of dressed stone.

The breakwater protecting the entrance is partly completed. It rests upon a stratum of rubble stone, and is made up under water of large concrete blocks in one or two courses, according to the depth of water. The superstructure is granite, extending 6 ft. above mean water level, and it is backed by loose stone and sand. The concrete blocks are 10 ft. 4 ins. high by 8 ft. 3 ins. long and 10 ft. 4 ins. wide. They are made hollow and weigh 36 tons each; the interior is filled with sand when in place.

The Monier type of construction, with iron network filled with cement mortar, will be used in the floors of the two-storied sheds and warehouses, and it enters into the construction of the concrete blocks in the breakwater. A double-track railway will extend along the quays; wire-rope transports will be provided for unloading coal, etc.; the grounds, warehouses and sheds will be lighted by electricity, and electricity will be used as a motive power for the 1½-ton movable cranes and the lifts in the warehouses and sheds. These cranes have been used successfully for some time at Rotterdam and Hamburg; they are so designed that the electric motor acts as a dynamo in lowering the load, thus generating current which is sent back to the accumulators. Engineers figure that in this manner about 20% of the electric energy is won back, in unloading a ship, and even 50% at times in loading operations.

It should be remembered that it is only in exceptionally cold weather, and then only for a few days, that the Sound leading to Copenhagen is obstructed by ice. The harbor and roads are kept open by a strong, natural current and by powerful ice boats, and the channel between Denmark and Sweden has never been closed, for at least one daily trip, in the last twelve years. The American grain trade will be a prominent factor in the expected commerce of this port; and, in fact, is looked upon as the chief factor. The promoters of this free port look upon it as a natural port of entry and exchange where the ocean steamers of America and other lands can bring their goods for eastern and northern Europe, to be trans-shipped into the smaller vessels trading on the Baltic; or stored in the winter, to be exchanged for commodities brought form the Baltic ports in the summer and placed in the warehouses for this winter's transport.

RAILWAY PROGRESS IN CHINA.

While railway progress is slow in China it has by no means been throttled by the popular outcry and prejudice, or by the secret machinations of the priests and some of the high officials. With the aid of foreign enterprise backed by the influence of the more enlightened officials, high in authority, China already has a railway in operation—the China Ry., from Tientsin to Kaiping, 85 miles; and has also a railway under construction—the Imperial Railway of North China, extending northeast from Tientsin. The China Ry. is of standard gage, with maximum grades of 0.33% and curves of 1° 54', or 3,000 ft. radius. The track is laid with 60 and 70-lb. T-rails of the Sandberg section, with angle-bar joints. The ballast is of 2 to 3-in. broken limestone, 9 ins. to 12 ins. deep under the ties, which are of chestnut, cost 60 cts. each and last about seven years. An interesting article on "The Railways and Telegraphs of China" was published in our issue of Nov. 17, 1892, with a map showing the lines built, under construction and projected.

The Imperial Railway of North China, running northeast from Tientsin, is progressing tolerably well, according to recent information received from Mr. C. W. Kinder, the Chief Engineer, who was formerly Chief Engineer of the China Ry. Co. Work has been somewhat slow on account of the amount of bridge work, but about the middle of February it was expected to get the rails laid to Shan Hai Kwan, on the Gulf of Liantung, within a few weeks. The Lan Ho bridge, 2,300 ft. long, is still backward, but as the pneumatic process of sinking the foundations is now being employed no further delay or difficulty is expected. But for the annual floods the bridge could probably have been completed in five months, and in any case there will not have been more than 17 working months spent on the work. Pin-connection bridges are used for spans of 200 ft. and over. Bridges of less than 200 ft. span are all English types, with plate girders up to 80 ft. span. In March work was commenced upon an extension about 130 miles long to Tah Ling Ho, 20 miles from Kiu Chow, in North China.

The Westinghouse Air Brake Co. sent a representative to China, but he found the outlook rather discouraging, and went to India. With a flat country, no curves, day service and slow trains, it is too early to adopt the Westinghouse brake upon mixed trains, as they need excellent supervision or are practically useless. Mr. Kinder states that for long trains it is the best brake, but for short trains he considers the vacuum beats it by reason of its great simplicity and freedom from leakage. As it

is, however, useless on long trains, when power brakes are needed in China at all, a high pressure one must evidently be adopted. It is proposed to fit two trains for passenger service, and thus test how the Chinese can work both systems.

NOTES FROM RECENT WATER-WORKS REPORTS.

A large iron tank was added to the water-works at Fall River in 1892, having been placed near the stand-pipe. It is 65 ft. in diameter, 56 ft. high and has a capacity of 1,389,976 gallons. The bottom of the tank is of ½-in. iron. The thickness of the sides of the tank is as follows: First 18 ft., 11-16 in.; next, 12 ft. 9-16 in.; next, 12 ft. 7-16 in.; last,, 14 ft. 5-16 in. The tensile strength of the sides is 55,000 lbs. per sq. in. All the rivets are of ¾-in. iron and are staggered. Triple riveting was used on the vertical seams for the first 36 ft., then double riveting, the rows in each case being 3 ins., c. to c., and the laps being 4½ ins. in width for triple, and 3¾ for double riveting. All horizontal laps are at least 2¼ ins. wide, and are single riveted. A 5×5×11-16-in. ingle iron is double riveted to the bottom and first side plate, outside of the tank, and a 3½×3½×½-in. angle iron, with the horizontal leg down, surrounds the top of the tank.

A ladder extends from within 15 ft. of the outside of tank to the top and down the inside to the bottom. A 24×30-in. manhole is provided near the bottom of the structure. A 16-in. supply and 8-in. waste pipe extend through and are double riveted to the bottom of the tank by means of a flange.

The tank rests on a foundation of stone in cement mortar, projecting 1 ft. outside the structure, and is bedded in cement and dry sand 2 ins. thick.

The consumption of water at Fall River in 1892 was 27.53 gallons per inhabitant and 30.08 gallons per consumer, 43% of the total consumption having been metered. Mr. P. Kieran is superintendent of the Fall River water-works. The above information is from the last annual report of the Watuppa water board of Fall River.

Sand filter beds to cover about 2½ acres are now being built for the water-works of Lawrence, Mass. The beds are located near the pumping station, close by the Merrimac River, from which the water supply is taken. The filtering material will consist of about 4 ft. of sand placed on about 1 ft. of screened gravel, graded from a diameter of 3-16 in. at the top to 2 ins. at the bottom.

The report of the Lawrence Water Board, from which the foregoing is taken, states that the 2½ acres of filtering area is designed to purify 5,000,000 gallons of water per day, removing 98% of the bacteria. The work up to the date of the report was being done with Mr. H. F. Mills, C. E., member of the Massachusetts State Board of Health, as consulting engineer, City Engineer Marble as engineer, and Superintendent A. H. Salisbury in charge of the labor.

Records of rainfall at New Bedford, Mass., by months, for the past 79 years, as furnished by Mr. Thos. Rodman, are given in the last report of the Water Commissioners of that city. The average yearly rainfall in this period was 46.559 ins. The minimum rainfall in this period is given as 34.51 ins. in 1846, and the maximum as 65.41 ins. in 1829. As a matter of curiosity, it may be stated that a total of 3,678.17 ins., or over 300 ft., of rain fell in the 79 years included in the table. Mr. R. C. P. Coggeshall is superintendent of the New Bedford water-works.

The report of the Water Commissioners of Springfield, Mass., for the year 1892 contains some interesting matter relating to an additional water supply main, including the two reports on the subject, from E. C. & E. E. Davis, engineers, of Northampton. At the close of the year the city council authorized the water commissioners to lay a main from the new Ludlow receiving basin to the city at a cost not exceeding $370,000, which will be met by 4% bonds. The new pipe line will consist of "not more than 25,000 lin. ft. of iron or steel pipe, 36 ins. in diameter, and not more than 42,000 lin. ft. of iron or steel pipe 30 ins. in diameter." Mr. C. L. Goodhue is chairman of the water commissioners, and Mr. J. C. Hancock is superintendent of the works.

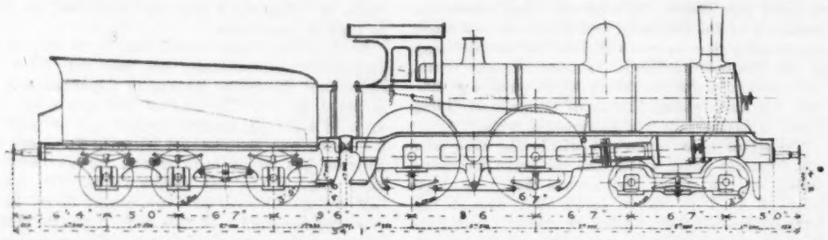


FIG. 1. FOUR-CYLINDER COMPOUND EIGHT-WHEEL LOCOMOTIVE; SOUTHWEST RY., RUSSIA.

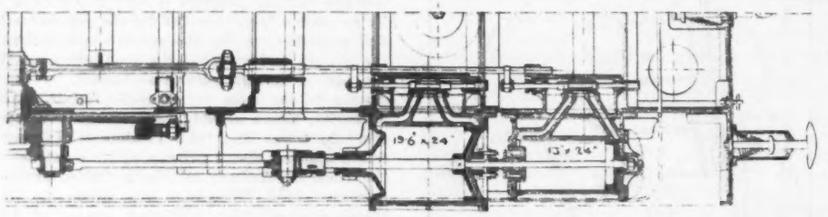


FIG. 2. PLAN OF CYLINDERS; FOUR-CYLINDER COMPOUND LOCOMOTIVE.

FOUR-CYLINDER COMPOUND LOCOMOTIVE; SOUTHWEST RY., RUSSIA.

The compound locomotive has made a more rapid advance in the United States than in any other country, and is here used on a large number of roads, the compound system having been applied to engines of various types and for all classes of service. In Europe the compound locomotive is coming into increasing favor, and various systems of compounding are in use. The Grazi-Tsaritsin Ry., in southern Russia, has a number of two-cylinder compound engines (Eng. News, June 14, 1890, and Jan. 2, 1892) built to the designs ofThomas Urquhart, M. Inst. C. E., the Superintendent of Motive Power, and these have shown very satisfactory performance in regular service. We illustrate this week a four-cylinder compound locomotive of the Southwest Ry., of Russia, the description of which we abstract from the report of the commission appointed to conduct the tests of the engine. Besides being of interest as a compound engine, the locomotives is another example of the extent to which the American eight-wheel type of engine is being adopted in England, as noted in our article of the Jura-Simplon Ry., Switzerland, in our issue of March 9.

The preliminary design of the Russian engine was prepared by Mr. de Borodine, and the design was worked out and the engine built by the Societe Alsacienne de Construction Mecaniques, of Belfort. The construction was under the supervision of Mr. A. Mallet, the well known French engineer, who was practically the originator of the two-cylinder compound locomotive (Eng. News, April 19, 1890, and Aug. 15, 1891), and who was appointed by the railway company to superintend this work.

The engine was ordered at the end of 1890, and was completed in September, 1891. It is of the American eight-wheel type, which, as already stated, is coming into very general use throughout Europe, having four drivers, with equalized springs, and a four-wheel leading truck. In Fig. 1 is given a general outline of the engine. Fig. 2 is a part plan showing the arrangement of outside tandem cylinders and inside valve chests, an arrangement which will be seen to involve extremely long ports, although these could have been avoided by placing the valves above the cylinders. Fig. 3 shows the arrangements for facilitating the inspection and repacking of the low-pressure piston, the right hand view representing in plan the piston pushed out of the cylinder. Fig. 4 is a cross-section, half through the high-pressure and half through the low-pressure cylinder.

In designing this engine it was desired to secure an engine as powerful as possible, within the limits fixed by the company, namely, 13 tons maximum load per axle, and 180 lbs. maximum boiler pressure, and at the same time so simple as to permit of the use of four cylinders, rendered necessary by the impossibility of making, for a two-cylinder compound a low-pressure cylinder of sufficient diameter. The cylinders outside are slightly inclined, and the two cylinders on each side are arranged tandem, with the high-pressure cylinder at the front end of the engine. The steam from the high-pressure cylinder on one side passes to the low-pressure cylinder on the other side of the engine, traversing a receiver in the smoke-box. In order to permit the engine to exert increased power in starting, an intercepting valve is fitted to allow the introduction of live steam into the low-pressure cylinders by a tube of small diameter to reduce its pressure on entering the cylinders. The fire-box is between the plate frames and between the driving axles. It was designed to be of corrugated

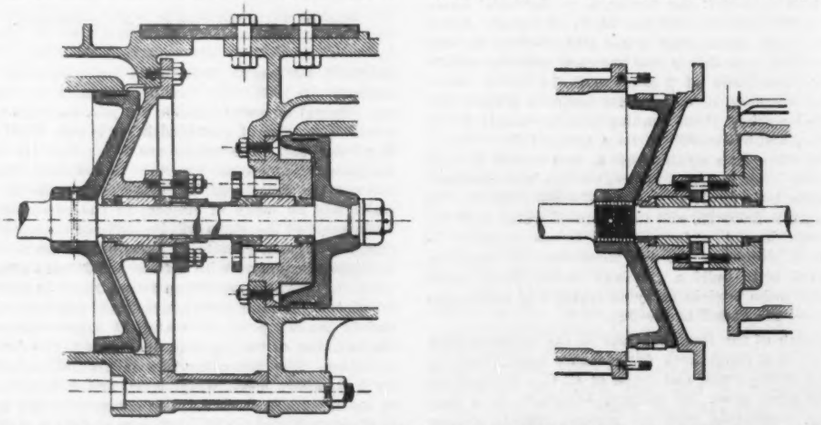


FIG. 3. ARRANGEMENTS FOR FACILITATING INSPECTION OF PISTON OF LOW PRESSURE CYLINDER.

copper, but the builders declined to make it for one engine, and it is therefore an ordinary firebox of the Belpaire type. The engine and tender are fitted with the Westinghouse brake. The leading dimensions and particulars of the engine are as follows:

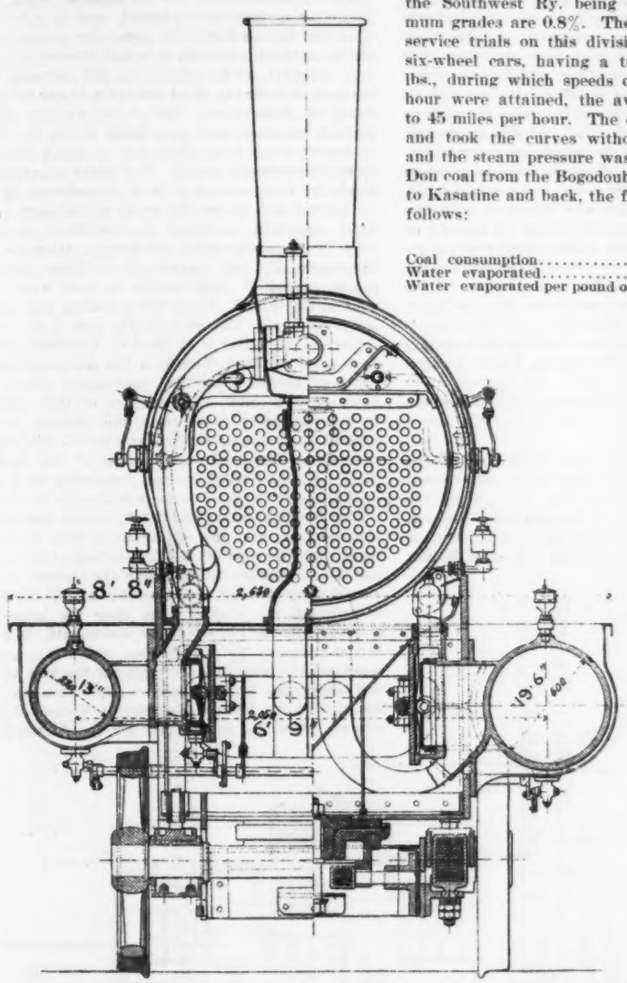


FIG. 4. CROSS SECTION THROUGH CYLINDERS; FOUR-CYLINDER COMPOUND LOCOMOTIVE.

Four-Cylinder Compound Locomotive; Southwestern Ry., Russia.

Running gear:	
Driving wheels, diam.	6 ft. 7 ins.
Truck " "	3 " 2 "
Tender " "	3 " 9 "
Wheel base.—Driving.	8 ft. 6 ins.
Truck.	6 " 7 "
Total engine.	21 " 8 "
" tender.	11 " 7 "
" engine and tender.	42 " 9 "
Weight, in working order.—On drivers.	57,200 lbs.
On truck wheels.	37,400 "
Engine, total.	94,600 "
Tender, total.	77,000 "
Engine and tender, loaded.	171,600 "
Engine, empty.	86,020 "
Tender, empty.	33,000 "
Allowed for water in boiler, and coal on grate.	8,580 "
Cylinders, h. p.	13 ins. diam.; 24 ins. stroke.
" l. p.	9.6 ins. diam.; 24 ins. stroke.
Ratio of area h. p. to l. p.	2 to 3
Distance, center to center.	6 ft. 9 ins.
Boiler.—Diam. of barrel inside.	4 " 2 "
Thickness of barrel plates.	0.56 "
Working steam pressure.	180 lbs.
Firebox.—Copper; type, Belpaire.	
Grate area.	20.44 sq. ft.
Tubes.—Number, 208.	
Diam. inside. 1.56 ins.; outside.	1.75 ins.
Length between tube plates.	12 ft. 5 ins.
Heating surface:	
Tubes, exterior.	1,205 sq. ft.
Firebox.	112 "
Total, with exterior tube area.	1,317 " "
Miscellaneous:	
Capacity of tank.	3,960 galls.
Capacity of coal space.	11,000 lbs.

The first engine proved entirely satisfactory in the preliminary tests, and was put in regular passenger service, when it was found able to haul heavier trains than the maximum allowed for ordinary engines and to thus avoid the use of two engines to a train. In express service between Kieff and Kasatine, about 100 miles, with trains of eleven to fifteen cars, the trains hauled by this engine were always on schedule time, and on this run with ordinary engines, even trains of eleven cars would have been run as double leaders, the maximum load for the heaviest engines on this division of the Southwest Ry. being eight cars. The maximum grades are 0.8%. The commission conducted service trials on this division, with a train of 15 six-wheel cars, having a total weight of 530,670 lbs., during which speeds of 47 and 57 miles per hour were attained, the average speeds being 30 to 45 miles per hour. The engine rode very easily, and took the curves without any shock or jerk, and the steam pressure was steady. The fuel was Don coal from the Bogodouhoff mines. On the runs to Kasatine and back, the fuel consumption was as follows:

	To Kasatine. lbs.	To Kieff. lbs.
Coal consumption	3,247	2,525.6
Water evaporated	28,173	23,379.4
Water evaporated per pound of coal.	8.68	9.26

Up to June 1, 1892, the engine had run 19,009 miles, and the commission reported that it had attained the purpose for which it was designed.

A SERIOUS BLAZE IN A FIREPROOF OFFICE BUILDING.

The most serious fire which has ever occurred, so far as we recall, in a thoroughly fireproof office building destroyed the contents of 30 or 40 offices in the Temple Court Building, on Beekman St., New York city, at 6 a. m. on Sunday, April, 2. The building is a ten-story structure, devoted solely to office purposes. The fire occurred in an annex to the main building, which was erected some three or four years ago. It broke out, as nearly as can now be determined, on the seventh floor, and spread through doors, windows and stairways to the three floors above, burning on each floor an area of some 800 to 1,500 sq. ft. So far as the tenants of most of the offices were concerned, their desks, books and papers might as well have been located in a tinder box. In at least a dozen rooms the fire made a clean sweep and destroyed everything combustible which they contained. Every particle of wood finish on walls, doors and windows, and wooden desks, chairs and bookcases were reduced to ashes. Only the charred remains of a few bound books and tightly packed papers were left amid the debris of plaster, mortar and ashes on the floor.

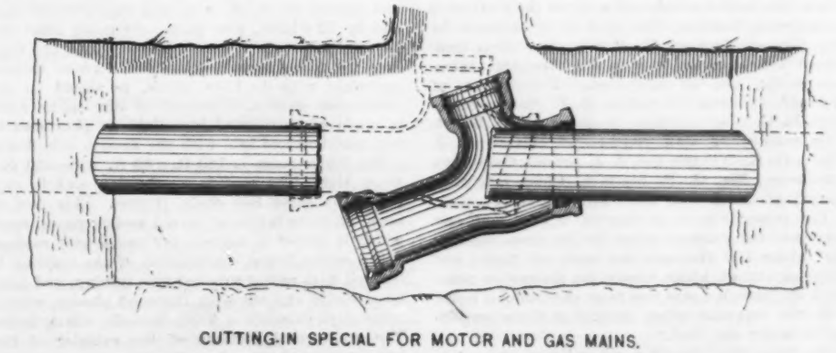
The framework of the building itself, on the other hand, was practically uninjured. The fire stripped every particle of plastering from walls and ceiling in some rooms, but the tile covering protecting the floor beams was not materially broken away in a single instance, and in only half a dozen or so places were patches of the fireproofing removed from the columns. An excellent illustration of the superiority of brick and tile as fireproof materials, compared with stone, was furnished by the stone window sills, from which great pieces spalled off. The brick and tile, on the other hand, were unaffected by the fire, save as the thin partitions of tile were lacking in stability, and portions of them were knocked down by the force of the streams of water.

The original cause of the fire is at present unknown; but the real cause of the damage done was lack of watchfulness and absence of provisions for checking the flames at their outbreak. There were no breaks whatever in floors or partitions by which the flames could spread, and only as they burned through heavy doors, and extended from one floor to another by the staircase and by the windows, were they communicated. The evidence is overwhelming, therefore, that the fire had been burning fiercely for hours before it was discovered; and still further proof is the fact that when the janitor, who was the sole occupant of the building at the time, discovered it, the blaze was so intense that he had to take refuge on the roof and remain there until the fire was put out.

The chief important lessons of the occurrence, therefore, are that thorough fireproofing will protect the ironwork of a building from the fiercest heat which the combustibles in ordinary offices will furnish; and further that the most thorough fireproof construction will not prevent the gradual spread of flames in an office building if they are allowed to have free course.

A CUTTING-IN SPECIAL.

It is often found necessary or advisable in connection with the extension of water or gas works to cut out a piece of the pipe and insert a special branch for a new main. This necessitates three joints, two for the special and a third joint or sleeve for connecting the broken length of pipe with the main line. As a simplification of this process Mr. H. F. Dunham, M. Am. Soc. C. E., has invented and patented the cutting-in special shown by the accompanying illustration, by means of which one joint is saved, the necessary trench excavation is reduced, and consequently the time and cost of introducing the special is diminished.



CUTTING-IN SPECIAL FOR MOTOR AND GAS MAINS.

As will be seen by referring to the cut, one end of the special is enlarged back of the bell, the face of which is slightly oblique to the axis of the special, thus making it possible to readily insert it as shown, and necessitating but two joints. At the back of the bell and parallel to its face there is a thin projection, or rib, which fits the main pipe, and forms an excellent stop for the yarn when the special has been brought into its proper position. The special is so made as to be adapted to pipes of varying thicknesses, and presents no difficulty in "making up."

The different uses to which this special may be put are obvious. The specials are made in all sizes for gas and water mains, and may be obtained from R. D. Wood & Co., Philadelphia.

WORLD'S COLUMBIAN EXPOSITION.—VI.

(With inset.)

Intramural Railway Power Station.

We illustrate in this issue the electric power station which is to furnish current to the Columbian Intramural Ry., and are indebted to Mr. B. J. Arnold, Consulting Engineer of the General Electric Co., for the drawings and for particulars concerning the design of the station.

As shown on the map published in our issue of Oct. 13, 1892, this road nearly encircles the Exposition grounds. An illustrated description of the superstructure and stations, as furnished by Mr. C. P. Matlack, Chief Engineer, was published in our issue of Oct. 20, 1892. Messrs. Remington & Co., contractors for the superstructure, inform us that the whole line, comprising 3½ miles of double track, has been erected, and work on the stations is progressing rapidly. The road is being built by the Western Dummy R. R. Co., and when completed will be turned over to the Columbian Intramural Ry. Co. for operation. The officers of this company are: President, B. E. Sunny; Secretary, E. C. Ward; General Manager, W. E. Baker. The engineering staff consists of Messrs. R. I. Sloan, G. K. Wheeler and B. J. Arnold, Consulting Engineers; Mr. G. P. Matlack, Chief Engineer; Mr. C. H. Macloskie, Electrical Engineer.

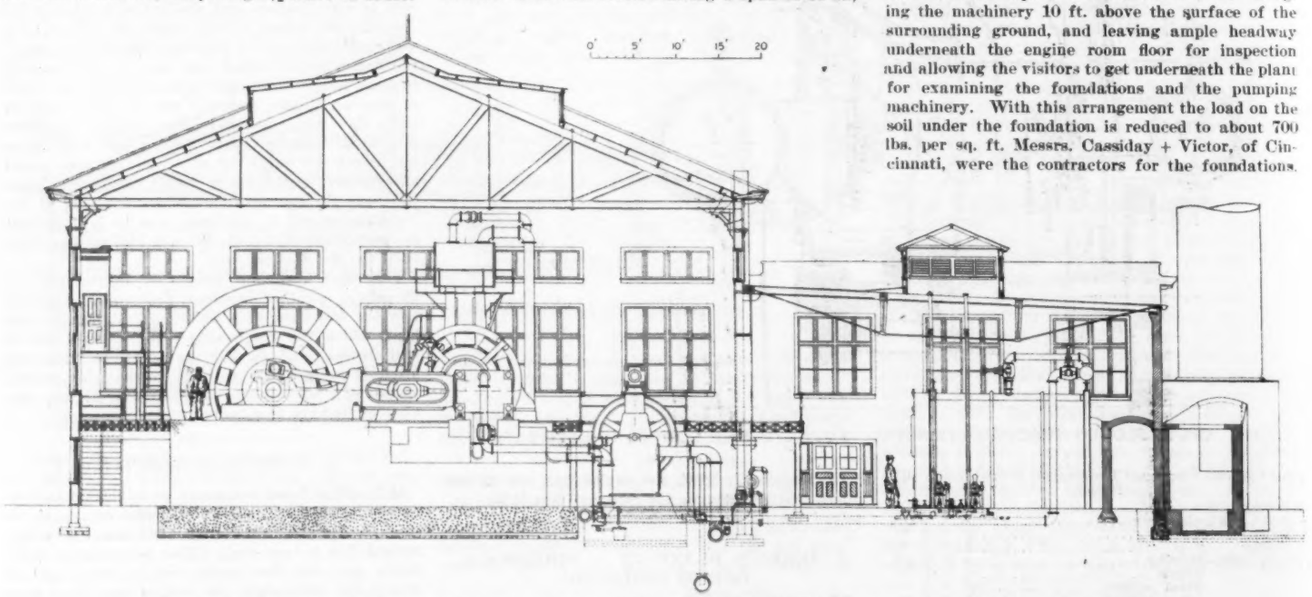
The power station is located in the southeast corner of the grounds, about 200 ft. from the lake and about 100 ft. from the main oil tanks and pumping station which supply the Exposition plant with oil through a pipe line from the Ohio oil wells. This site was selected on account of the accessibility to water and fuel.

Our inset sheet shows a general plan and a longitudinal section of the station, and a transverse section is shown herewith. It will be noticed from these drawings that the entire machinery plant is surrounded with a passageway for visitors, so that a spectator can stand in almost any location in the building and watch the working of the entire plant. At the same time those in charge of the station are kept separate from the crowd, and cannot be hindered in their duties by the sightseers. The engineers have ample space inside the railing surrounding the engines, and can pass from one engine to another without opening gates or climbing over any obstructions. The spectators, at the same time, can view the machinery from any side. The firemen are in the lower story, and have a direct passage from the boilers to the condensers and air pumps, but do not come in contact with the visitors or any one on the upper floor. At the same time the engineers can keep the whole plant under inspection, and can see at all times what is going on in the engine room, boiler room and condenser pit.

Building.—The building was designed with the view of making it reasonably cheap on account of its temporary nature, but at the same time as attractive in appearance as possible, and arranged for exhibition purposes so far as the nature of the case would permit. The contractors for the building were Messrs. McArthur Bros., of Chicago.

It is of frame and staff construction, with the exception of the rear wall between the boilers and the stack, which is built of brick. All timbers used in the building are cut as little as possible, in order that the material may be utilized after the Exposition is over.

The engine and generator room is 140 ft. × 80 ft., and about 25 ft. high in the clear below the trusses. There is a basement to this room 10 ft. high, extending from the surface of the ground to the engine room floor. The roof of the engine room is carried on wooden trusses having a span of 80 ft., and spaced 15 ft., c. to c., and supported at each end by 12 × 12-in. pine posts, extending from the lower chord of the truss to the footings. The footings for these posts are built of 8 × 8-in. timber, underlaid with 4 × 12-in. plank, as shown on the transverse section. The roof of the engine room is made of corrugated iron, laid on pine sheathing, matched and laid with the smooth side down.



TRANSVERSE SECTION OF POWER HOUSE FOR INTRAMURAL ELECTRIC RAILWAY; WORLD'S COLUMBIAN EXPOSITION.

The boiler room is 140 ft. × 49 ft. wide and one story high. The roof is nearly flat, and is supported by eight hog chain trusses. This roof is made of three layers of tarred roofing paper, upon which is placed a common tar and gravel roofing.

The entire frame construction of the building is covered with patent grooved pine lathing, and plastered inside and out with Diamond plaster, which, when dry, presents a hard, smooth, white finish. The ornamental portions of the exterior of the building are built of staff, the same as used on other buildings on the Exposition grounds.

Foundations.—Inasmuch as this station stands upon a layer of sand, which is submerged in water all the time, but if allowed to get away takes the nature of quicksand, the question of foundations for supporting the mass of machinery, weighing with its foundations about 2,800 tons, is quite important. To have driven piling to build the foundations in the ordinary manner would have cost more money than it was thought best to spend upon the construction for six months' work. The following method was adopted, and it is believed that the foundations will stand the severe strain put upon them, although it is well known that electric railway work, owing to the extreme fluctuations of power at short intervals, is exceptionally hard on foundations. The entire surface of the ground was excavated to a depth of 3½ ft., which is below frost line. This left a clean sheet of sand submerged in water. If a slight excavation is made in this surface it will immediately fill up with sand and water, the same as ordinary quicksand, although it cannot be construed as being what is commonly called quicksand. Over the surface was laid two layers of 3 × 12-in. hemlock plank, placed at right angles to each other, and thoroughly spiked. Upon this planking was built a concrete block 135 ft. × 60 ft. and 3 ft. thick, composed as follows: 1 part of Portland cement to 4 parts of sand (found on the premises) and 4 parts of broken limestone, thoroughly mixed and rammed into place. The surface of this concrete is approximately level with the surface of the ground surrounding the power station. On top of this stone the brick foundations of the engines were built in cement mortar, consisting of 1 part of American Portland cement to 3 parts of sand.

The foundations extend 10 ft. above the top of the concrete, and the engine room floor is placed level with the tops of the foundations, thus bringing the machinery 10 ft. above the surface of the surrounding ground, and leaving ample headway underneath the engine room floor for inspection and allowing the visitors to get underneath the plant for examining the foundations and the pumping machinery. With this arrangement the load on the soil under the foundation is reduced to about 700 lbs. per sq. ft. Messrs. Cassiday + Victor, of Cincinnati, were the contractors for the foundations.

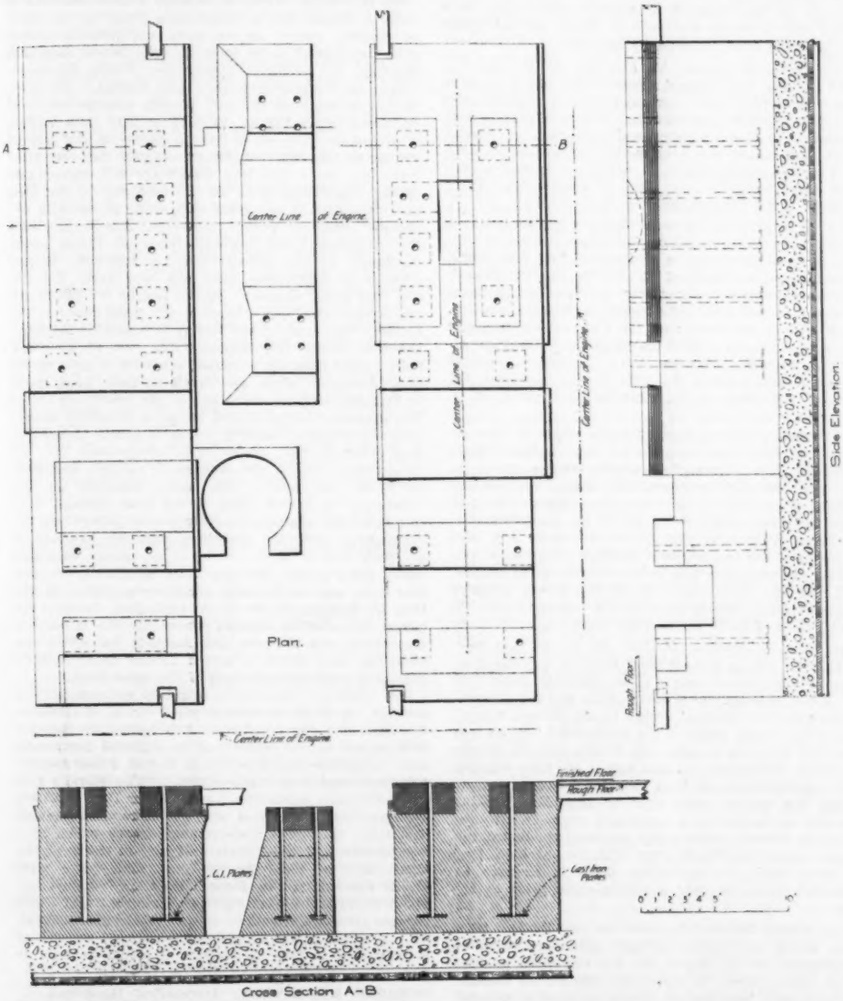
Engines.—In the engine room will be located the following equipment.

At the east end of the room will be a 22 × 42 × 48-in. Reynolds tandem compound Corliss engine, built by the E. P. Allis Co., of Milwaukee, Wis. To the shaft of this engine is coupled direct a 500-K-W. multipolar generator. This engine will run at 80 revs. per minute, and will develop from 750 to 1,000 HP. Adjacent to this engine stands a 22 × 44 × 36-in. cross-compound Hammond-Williams vertical engine, built by the Lake Erie Engineering Works, of Buffalo, N. Y. To the shaft of this engine is coupled direct a 500-K-W. multipolar generator, which will run at 100 revs. per minute, and develop from 750 to 1,200 HP., depending upon the load required.

In the west end of the building stands a 20 × 38 × 48 tandem compound Greene engine, built by the Providence Steam Engine Co., of Providence, R. I., belted direct to a 500-K-W. multipolar generator. This engine will run at 100 revs. per minute and develop from 750 to 1,000 HP. The belt is supplied with an idler, or tightening pulley, furnished by the Eclipse Clutch Works, of Beloit,

Wis. The belt is 48 ins. in width, and was furnished by the Page Belting Co., Concord, N. H. Just east of this engine, and adjacent thereto, stands a 13 × 23 × 22 McIntosh & Seymour tandem compound engine, coupled direct to a 200-K-W. multipolar generator.

This engine and generator will run at 150 revs. per minute and develop from 300 to 400 HP.. In the middle of the building stands a 32 × 42 × 60-in. cross-compound Reynolds-Corliss engine, built by the E. P. Allis Co., of Milwaukee, Wis. To the shaft of this engine is coupled direct a 1,500 K-W. multipolar generator. This combined machine will run at a speed of 80 revs . per minute, and will develop from 1,500 to 2,500 HP. This generator is the largest electric generator yet constructed. The main shaft upon which the armature is built is 24 ins. in diameter, 30 ft. long, and weighs 55 tons. This shaft was built by the E. P. Allis Co., at Milwaukee, and was brought to the Exposition grounds



FOUNDATION FOR 2,000 H.P. REYNOLDS-CORLISS CROSS-COMPOUND ENGINE AND 1,500 K-W. DIRECT-CONNECTED DYNAMO IN INTRAMURAL RAILWAY POWER STATION.

on a specially constructed car furnished by the Chicago & Northwestern Ry. Co. The armature of this machine is 14 ft. in diameter. It was shipped in parts to the power house, and will be erected and wound in place.

All of the generators and other electrical machinery of the plant, as well as the motors to be placed on the cars, were furnished by the General Electric Co., and were manufactured at the Lynn and Schenectady factories.

Condensers and Boiler Feed Pumps.—From the transverse section it will be noticed that the condensers and boiler feed pumps are all placed in a row in the rear of the engines, and that the floor is left open, the opening being surrounded with a gallery, so that the spectators can see this machinery at work. In this pit will be located two vertical Allis jet condensers and air pumps attached to the Allis engines; one Conover jet condenser and air pump, coupled to the Williams engine; one Worthington duplex jet condenser, coupled to the Greene engine; one Deane single-acting jet condenser, coupled to the McIntosh & Seymour engine; one Smith-Vaile duplex boiler feed pump, which is also intended for fire purposes; and one Gould Mfg. Co.'s triplex boiler feed pump.

Boilers.—There are ten Babcock & Wilcox water tube boilers installed in the plant, having a rated capacity of 3,000 HP., but capable of developing a maximum of 5,000 HP. when the engines are running condensing, as all engines are in this station. Between the boilers and the rear wall of the building will be noticed a smoke flue leading to the stack, and outside the building and on each side of the stack are two batteries of Greene's fuel economizers, furnished by the Fuel Economizer Co., of Matteawan, N. Y., through which the feed water from the pumps will be forced before entering the boilers. It will be noticed on examining the damper arrangement that the gases can be turned through these economizers or direct to the stack at the will of the operator.

Oil Burning Plant.—At the west side of the boiler room stands the small pumps, stand-pipes and other necessary devices for pumping and delivering the fuel oil to burners under the boilers. These pumps take the oil from the tanks of the Exposition company, through 2-in. pipes, laid underground, and maintain a constant pressure on the burners, by means of stand-pipes, of about 5 lbs. per sq. in. The fuel oil installation is supplied by the National Supply Co., of Chicago.

There will be several forms of oil burners used under the boilers, and an attempt will be made to arrive at the relative efficiency of the various burners now on the market, and also to determine if possible the relative cost of power when furnished by oil and by coal.

Pipe.—The water from the lake, for condensing purposes, is secured through an 18-in. vitrified sewer pipe, provided with two lengths of cast iron pipe at the lake, and a valve for shutting off the water in case repairs are necessary. This pipe is laid with the lake end 3 ft. below low water line, and slopes toward the power house. Above this pipe, leading from the power house, runs another 18-in. sewer pipe, with a grade inclined toward the lake, with the lake end 1 ft. above high tide line. It will thus be noticed that the water flows to the power house by gravity. The condensers take water from this pipe, lift it about 8 ft., where it comes in contact with steam from the engines, and deliver it back to the upper pipe, through which it flows back again to the lake. Thus the air pumps do not suck the water from the lake, but simply lift it vertically a short distance.

The steam from each boiler is led through a 7-in. pipe to the main steam header, which is 14 ins. in diameter, and extends the entire length of the boiler plant. From this header three pipes drop downward, thence run horizontally underneath the engine room floor to points near the engines, from which they rise, and branch lines are laid to the respective engines, condensers and pumps. Inasmuch as there are three independent leads from the main header to the engines, and the main header is supplied with a valve near its center, the plant cannot be shut down on account of accident to any particular part of the pipe.

It will be further noticed that the pipework is supported entirely from the boilers and from the ground, no part of it being attached to the building. It was not thought advisable to attempt to suspend the pipework from the building on account of its temporary construction, and the idea throughout the entire plant has been to make the machinery and boiler plant entirely independent of the building, so far as possible. The steam piping throughout is supplied with bronze-seated valves, furnished by the Chapman Valve Co.

Switchboard.—In the center, and on the north side of the building will stand the switch board, a half story above the engine room and high enough to permit visitors to pass underneath it.

The executive officer of the power station will be located on the switchboard platform, from which he will have complete supervision of the entire plant. There will be speaking tubes and electric bells running from this switchboard to the different engines, generators and boilers, so that one man can direct the entire work without changing his position.

It is expected that this plant will show as great economy as has ever been obtained in electric railway work. It will furnish current for 18 trains weighing from 65 to 85 tons each. Each train will be equipped with one motor car and from two to four trailers. Each motor car will be supplied with four single-reduction motors attached one to each axle, each motor having a maximum capacity of 125 HP., or a total of 500 HP. to each motor car, although the normal rating of the motors is but 50 HP. each. The trains will run on a headway of two minutes, over a track with many sharp curves and grades varying from ½ to 1½%.

The current will be supplied to the trains through a third rail, weighing about 60 lbs. per yd., laid about 18 ins. to one side of the track. This rail will be supplemented with one or two additional rails where the quantity of current or the distance demands it. The return circuit is made through the I-beams which support the structure, supplemented by the main track rails. The current will be taken from the rails by two sliding shoes or trolleys attached to the trucks of each motor car. The trains will be equipped with air brakes, and with the latest form of series multiple controllers. The road will be equipped with the Rowell-Potter Safety Stop Co.'s block signal system.

Transportation Facilities.

At the annual meeting of the directors of the Exposition company, on April 1, the president, Mr. Higinbotham, referred to the efforts made to secure the right of way of the Baltimore & Ohio R. R. into Jackson Park, and the elevation of the Illinois Central R. R. tracks, both of which were consid-

ered necessary if 150,000 people an hour were to be conveyed to Jackson Park. He said that $250,000 had been contributed by the Exposition company for the elevation of the Illinois Central R. R. tracks, and gave the following table, showing the capacity of the different transportation lines for carrying passengers from the city to the Exposition grounds:

Chicago City Railway, Cottage Grove cable line,.	20,000
Chicago City Railway, State St. and 63d St. lines.	20,000
Illinois Central R. R., on existing tracks.....	21,600
Illinois Central R. R., on additional through tracks.	14,400
Water transportation between the Lake Front and Jackson Park.....	10,000
Water transportation between points on the North Side and Jackson Park.....	5,000
Chicago & South Side Elevated Ry.....	20,000
Making a total per hour of.....	110,000

It is estimated that fully 25,000 people will reach the grounds on foot and in vehicles by means of the subways under the tracks of the Illinois Central R. R., thus making the total 135,000 an hour. This total can be maintained for from three to four hours in the morning, and for the same time in the evening, by which it is apparent that 300,000 can be carried to the park in the morning in a little over two hours, and returned in the evening in the same space of time.

The new Berlin underground electric railway is to make the distance of 2½ miles in 7 minutes, or about 43 miles per hour.

Engineering affairs in Egypt were formerly managed in a delightfully original manner, according to an item in "Indian Engineering." When the drawbridge across the Nile, at Kafr Zayat, was officially opened, says our contemporary, the Khedive complimented the engineer upon his work. This official is reported as then having considered it his duty to inform his Highness that if anything happened to the swinging part of the bridge there was nothing on hand to repair it with, and serious delay to traffic might occur. He recommended the purchase of an extra drawbridge; and the bridge was bought and lay piled up there for years ready for use. The same journal says that some years ago a music-master in the Khedive's household obtained a concession of all the sewage of Cairo. He sold his concession to a company and retired to Italy with a modest fortune. The company built its poudrette works, south of the city, and then under the terms of the contract demanded that the sewage should be delivered by carts at the works, for there were no sewers in Cairo. The authorities declined to comply with the modest request; but to avoid an appeal to the International Court and possible heavy damages, the government finally compromised at a handsome figure. It is hardly necessary to say that these events were supposed to have happened before England took upon herself the management of Egyptian affairs.

PERSONALS.

Maj. F. F. Brune, mining engineer, died in Denver, Colo., March 23.

Mr. Joseph P. Phillips has been appointed City Engineer of Scranton, Pa.

Mr. E. R. Baker has been appointed City Engineer of Gloversville, N. Y.

Mr. A. F. Priest has been appointed Master Mechanic of the Duluth, Mesaba & Northern Ry.

Mr. H. F. Royce, General Superintendent of the Chicago, Rock Island & Pacific Ry., has resigned.

Mr. L. W. Burt, City Surveyor of Hartford, Conn., has had his salary raised from $2,000 to $2,500 per year, by unanimous vote of the Council.

Mr. Theodore Cooper, of the class of '58 of the Rensselaer Polytechnic Institute, delivered a lecture on "Specifications" before the students of that institution, March 29.

Mr. E. L. Corthell, M. Am. Soc. C. E., of Chicago, is having plans prepared for the New Orleans bridge, and is also consulting engineer of two bridges on the Jacksonville Southeastern R. R.

Mr. J. E. Grenier, M. Am. Soc. C. E., for the last 18 months Engineer of the Philadelphia Bridge Works, Pottstown, Pa., has accepted the position of Engineer of Bridges for the Baltimore & Ohio R. R.

Mr. R. H. Aishton, Division Engineer of the Northern Iowa Division of the Chicago & Northwestern Ry., has been appointed Assistant Superintendent of that division, with headquarters at Eagle Grove, Ia.

Mr. A. A. McLeod, President of the Philadelphia & Reading R. R. Co., and the Philadelphia & Reading Coal & Iron Co., has tendered his resignation from the presidency of those companies, to take effect May 1. He will also resign from the receivership of the company.

Mr. Gus C. Henning, M. Am. Soc. M. E., was one of the tenants of the Temple Court Building, New York city, whose offices were wrecked by fire in that structure, noted elsewhere. Among the papers burned were the records of the committee of the American Society of Mechanical Engineers which is at work on a uniform system of tests of materials. Mr. Henning's address for the present will be No. 220 Temple Court, New York city.

Mr. Louis Enricht has joined the firm of Alexander & Hill, civil engineers, Chicago, which will now be known as Alexander, Hill & Enricht. He was engaged on the surveys and location of the Central Pacific R. R., and has had charge of reclamation, street work, etc., as a member of the engineering and contracting firm of Torrens & Enricht, of San Francisco, Cal. He has also been engaged in mining enterprises.

Mr. John E. Thomes, a well known railway engineer, of Kansas City, Mo., died March 7, 1893. At the age of 19 he joined the corps of the Union Pacific Ry. surveys, and later held positions of responsibility on several of the Pacific through lines. He was at one time Chief Engineer of the Atlantic & Pacific R. R., and latterly he was engaged in railway construction. His death was noted in our issue of March 16, but under the name of J. E. Thomas, by mistake.

Mr. Frank M. Dunlap, M. Am. Soc. M. E., and Mr. Will Dunlap, have formed a partnership under the firm name of Dunlap Bros., for conducting a general practice in mechanical engineering, and will give special attention to the designing and inspection of special machinery. They also have working arrangements with civil and electrical engineers, and are prepared to execute commissions in any line of engineering. Their office is in the Cleland Building, Detroit, Mich.

Mr. C. C. Elwell, Division Engineer of Maintenance of Way, Pittsburg Division, Baltimore & Ohio R. R., has resigned to accept a position on the New York, New Haven & Hartford R. R. Mr. J. F. Cassell, Division Engineer, Parkersburg & Wheeling Division, has been transferred to the Pittsburg Division, and Mr. H. E. Hayes, Supervisor on the Philadelphia Division, has been promoted to Division Engineer of the Parkersburg & Wheeling Division. Mr. D. G. Morton, formerly with the Richmond & Danville R. R., has been appointed Supervisor on the Philadelphia Division, B. & O. R. R.

Mr. Belpaire, the eminent Belgian engineer, and director of the administration of the Belgian State Railways, died at Brussels, recently, at the age of 73. He was educated at Paris, and began his railway experience in 1841 as an assistant engineer. He had been for many years the head of the Executive Department of the Belgian State Railways, and was President of the International Railway Congress, a convention of which was held in St. Petersburg, in August, 1892. He was the inventor of the well known Belpaire type of firebox, largely used in this country, and of a special form of grate for burning small coal.

Mr. John F. Haskins, M. Inst. M. E., M. Am. Soc. M. E., who died in Philadelphia, Feb. 24, was the principal organizer and manager of the Burleigh Rock Drill Co., which supplied the Burleigh drills and the air-compressors of Mr. Haskins' design to the Hoosac tunnel. During the earlier years of his professional life he was connected with the Morgan Iron Works, and the Shanghai Steam Navigation Co., and was at one time engaged in the manufacture of John Ericsson's caloric engine. During the eleven years prior to 1889 Mr. Haskins practiced in London as a consulting engineer. He returned to America three years ago, and conducted the Eastern agency of the Stearns Mfg. Co., of Erie, Pa., for some time. He opened an office in Chicago as consulting engineer, only a few months prior to his death.

Gen. Hiram Berdan, inventor of the Berdan rifle, range finder, and other military appliances, died in Washington, D. C., March 31. He was born at Plymouth, Mich., about 70 years ago, and served through the war. His best known invention was a metallic cartridge now in general use, the reinforcing cup being his particular improvement. Many of his inventions have been incorporated in the Springfield rifle, and a year ago the Court of Claims gave him a judgment for $100,000 against the government for infringements. The Berdan rifle has for several years been in use by the Russian government, and other European countries have adopted variations of the same model. He also invented a range finder and several torpedoes and torpedo boats designed to evade nets. He also made a "distance fuse" for a sharpened shell. Immediately after the war General Berdan worked with the Remingtons, but had difficulties with them, and left to establish the Berdan firearm manufactory. This concern practically expired with General Berdan's patents three years ago, but has since been reincorporated.

NEW PUBLICATIONS.

APRIL MAGAZINES.—The "Popular Science Monthly" opens with the address of President David Starr Jordan, delivered at the dedication of Science Hall, at the University of Illinois, last November. "Science and the Colleges" is the theme of the address, and the story of the victory which science and the scientific method has won at all the higher institutions of learning has never been better told. Everyone who takes an interest in the conflict which has so long been carried on in the colleges between the classics and the sciences should read this masterly record of the results. Mr. John Gifford writes of the abandoned furnaces and bloomeries which once supported a thriving population in Southern New Jersey, the ore used being the bog iron ore from its shallow lakes and swamps. In the early part of the present century the iron manufacture was the principal industry of that section, but now scarcely a trace of the old works remains. The "Californian" this month is a Hawaiian number, and has several excellent articles on the Sandwich Islands and their present political situation. In "Harper's" Julian Ralph comes home to write a monograph on Brooklyn, and his description of the human torrent which flows twice a day across the great bridge is a piece of writing worthy of especial praise. Ex-Senator John J. Ingalls has an interesting paper on the state of Kansas, but it is historical and political rather than commercial in its tone. In the "North American Review" U. S. Naval Constructor Philip Hichborn writes on "Shipbuilding Here and Abroad." He gives figures in detail of the cost of ship construction, and estimates prices for the building of first class vessels in this country as about 20% in excess of the cost of similar vessels in Great Britain. Considering that steel costs 50% more here and wages are 80% higher this speaks remarkably well for the efficiency of the men and machinery in our great shipyards. In building the cheaper class of vessels, however, Americans, with the exception of the shipbuilders on the Lakes, stand no show. At the present time a well-built British steamer of 1,620 gross tons will cost about $70 per ton, and tramp steamers can be bought for $48.50 per ton—a sum which must leave a very small profit to the builder. The cause of the decline of American shipping, however, is less the increased first cost of American built vessels than the increased expenses of their operation. American ships are taxed in their home port. In England only the net profits on the vessel are taxed. The President of the United States & Brazilian Steamship Co. recently testified before a Senate committee that, whereas the wages and provisioning for the "Seguranca," one of the steamers of his line, amounted to $3,428 per month, the same expenses on the "Glengoyl," a British tramp of the same tonnage, were only $1,256 per month. It is little wonder under these circumstances, that the American company has had to succumb, and on April 3 three of its vessels were sold under the hammer for less than one-fourth of their first cost. Another paper in the same magazine, by Mr. Geo. F. Becker, of the U. S. Geological Survey, discusses the existing theories concerning the interior of the earth, and explains the methods by which our globe has been shown to have a rigidity about equal to that of a solid mass of steel of the same form.

The "Century" this month might be called a forestry number. A finely illustrated paper by M. C. Robbins describes the famous Arnold Arboretum, at Harvard College, and among subjects of the editorial department are "A Memorable Advance in Forest Preservation," "Parks in and Near Large Cities," "The World's Fair and Landscape Gardening," and "Arbor Day." Among the open letters is one of very great practical interest, describing the public employment bureaus which have been established under state authority in the five principal cities of Ohio. In the year 1891, there were 57,579 applications to these offices for employment, 34,371 applications were made by employers, and 15,525 persons obtained situations through their instrumentality. A more practical and praiseworthy method of helping men to help themselves, it would be hard to find.

PUMPING MACHINERY. A Practical Hand-book relating to the Construction and Management of Steam and Power Pumping Machines. By William M. Barr, M. Am. Soc. M. E., Philadelphia. 8vo. J. B. Lippincott Co., pp. 457; 260 illustrations. $5.00.

This is really, as the title indicates, a practical treatise upon pumping engines, written from the standpoint of a pumpmaker. Little or no mathematics and formulas are indulged in; and the history of the pumps described is confined to the name of the inventor and the date of patent. But every detail of modern pump-construction is described in plain terms and well illustrated; and what is more, and constituting the real value of the work, these descriptions are accompanied by words of caution and advice evidently derived from a practical knowledge of pump mechanism and its manufacture. Almost every conceivable type of modern pump is included, and the whole work is one that can not fail to be useful to those interested in the design of machines of this nature. It is well printed in large type, upon heavy paper; though the illustrations are usually without scale or dimensions, the text is sufficiently explicit to make up for this lacking feature. Considerable space is devoted to duty-trials and high-duty pumping engines,

ELECTRICAL MEASUREMENTS AND OTHER ADVANCED PRIMERS OF ELECTRICITY. By Edwin J. Houston, A. M., Professor of Natural Philosophy and Physical Geography in the Central High School, Philadelphia; Professor of Physics, Franklin Institute, etc. New York: The W. J. Johnston Co., Ltd. 12mo, pp. 429; illustrated. $1.00.

This is the second volume of Professor Houston's series of elementary electrical treatises intended for the use of students and non-technical readers. These primers are each complete in themselves, and the present volume in its first primer treats in plain terms of the meaning and methods of measuring electric currents and electric resistance, electromotive force, voltaic and thermo-electric cells, etc. Other so-called primers follow in this same volume to the number of eighteen, each devoted to some special branch of the subject. These include the principles upon which commercial currents are based; the principles and application of dynamos, motors and transformers; and the discussion of electric lighting and power covers over 200 pages of the volume, and forms a concise treatment of this subject that will be particularly useful to the non-technical man seeking after information. The 160 illustrations add much to the generally useful character of the work.

SWITCH LAYOUTS; Showing Graphically the Leads, Offsets and All Dimensions Needed for Locating Frogs of All Numbers and Curves in All Switches in Common Use; also, Tables of Angles, Chords and Deflections for Easing the Transition from a Tangent to a Curve, and from a Curve of One Radius to a Curve of Another Radius. By Augustus Torrey, Prin. Asst. Eng., Michigan Central R. R. New York: The "Railroad Gazette." Oblong 12mo, pp. 191; 112 detail diagrams. $1.00.

This is by long odds the most sensible and convenient switch book we have ever seen. It gives 112 different cases by as many distinct diagrams, occupying one page each, all fully worked out with detail dimensions and offsets, so that any man with a foot rule or a tape line can lay out a turn-out (so far as its position on the ground goes), whether he ever saw one before or not. We have not had the curiosity to examine what particular formulas the author has chosen to adopt out of the endless assortment which the ingenuity of man has devised for such use. We do not perceive that it matters much. The main thing is to have something definite to go by; the fractional differences which result from differences in the assumptions made are of no real moment. The easement-curve formulas and tables we cannot so cordially approve in respect to simplicity of use, but they will give very good curves without very much work, and hence they also will serve a very good purpose.

TRADE PUBLICATIONS.

ROAD MAKING.—Tomkins Cove Stone Co., New York. 16mo, pp. 13.

While the purpose is to show the superiority and advantages of the company's stone, there are some useful notes on road construction and maintenance. The material is a blue stone, furnished as 2-in. broken stone, screenings, and fine screening, the latter being suitable for footpaths.

GLOBE SPECIAL CASTINGS FOR WATER-WORKS: Builders Iron Foundry, Providence, R. I.

This little illustrated pamphlet gives prices for the well known globe specials made by this firm and also the prices of some other water-works specials. The Venturi meter (see Eng. News, July 7, 1892, for complete illustrated description) is briefly described in the pamphlet.

OUTDOORS.—Pope Mfg. Co., Boston, Mass. 12mo; pp. 80; illustrated. 10 cts.

While this little book is issued by the well known bicycle manufacturers, there is no advertising in the reading pages, which include illustrated articles on lawn tennis, yachting, cycling, rowing, riding, canoeing and other sports.

SOCIETY PROCEEDINGS.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on April 5, a paper by Mr. Walter McCulloh, on "The Construction of a Water-Tight Masonry Dam," was read. The dam described was the Sodom Dam on the Croton Aqueduct system, at what is known as "Double Reservoir L," or more familiarly as Sodom and Bog Brook Reservoir. This reservoir consists of two basins joined by a 10-ft. circular tunnel 2,000 ft. long, through which the water passes from the basin which has the larger water-shed into the Bog Brook basin, which has only 3½ sq. miles of water-shed, with a storage capacity nearly as great as the former which drains 73.42 sq. miles. The combined storage capacity obtained in this manner is 9,500,000,000 gallons. Sodom Dam, which impounds the water in the larger basin, is of masonry throughout, and the Bog Brook Dam is of earth only. The Sodom Dam spans a gorge and is 500 ft. long at the coping line, which is 78 ft. above the river-bed.

Examinations at the site were made by test pits and borings in 1886. The dam crosses the valley at right angles to the stream which here flows to the north, and at the site adopted the hill to the east showed an outcrop of hard gneiss rising abruptly 30 ft. above water, with bowlders and gravel at its foot. The rock back from this rose about 40 ft. in 100, and was covered with a few feet of soil. The slopes on the west side were 15% at water surface, diminishing to 5% at top of dam, and the rock, which was from 4 to 10 ft. below the surface, was decomposed and shaly for a depth of about 15 ft. The rock in the riverbed was solid, and was overlaid by a light deposit of sand and gravel. The ridge to the east, below the site of the dam, was parallel to the river and about 75 ft. above it, and a dam of earth 600 ft. long was constructed upon it to the height of the masonry dam, and at the north end of this earth dam is the spillway dam, which is a masonry wall 8 ft. high and 500 ft. long, with the lip 10 ft. below the top of coping of the Sodom Dam, and 6 ft. below the flood line. After passing this the waste-water follows through an old water-course in a channel cut to the rock and between curved retaining walls.

The greatest height of the dam (above rock) is 98 ft., the thickness at bottom is 53 ft., and under the coping 12 ft. The total batter on the lower face is 37 ft., decreasing from 9.3 in 10 to 2.7 in 10. The batter on the back is 10% up to 38 ft. below the top, and plumb above that point. The gatehouse is 37 × 42 ft. and rises 23 ft. above the dam near the center. The discharge is through two 48-in. pipes, which pass through the body of the dam. The work was begun Feb. 22, 1888, and completed and accepted Oct. 31, 1892, nearly three years after the date fixed by the contract. The floods in the stream rise suddenly and the discharge in a spring freshet reaches 250,000 cu. ft. per minute. To control this during construction, a timber crib-dam was thrown across the river about 80 ft. above the site of the work, and a canal cut 26 ft. wide and 15 ft. deep on the west side and around the work to a point 500 ft. below. The gatehouse and eastern half of the dam were then built to about 25 ft. above the discharge pipes, and in the dry season of 1889 the water was turned through the pipes and the other half of the dam started.

In preparing the foundation, all loose rock was removed by dynamite; and, afterward, all loose seams or shakes by blasting with black powder and barring out. The foundation was swept with wire stable brooms, and washed clean. All pockets or holes were then filled with rich Portland cement concrete. A tighter bond, it was found, could be made with rubble consisting of small stones, than with concrete beds. Water entered through several seams in the rock, and would wash the mortar out of the concrete, but it could be led around the rubble beds, until finally a small well, 2 ft. in diameter and 1 ft. deep, was formed at the point where the water boiled up. After the mortar had set, the well was bailed out and filled quickly with dry mortar; on top of this a bed of stiff wet mortar was laid, and capped by a large rubble stone. After the first 6 ft. of the rubble foundation had been placed, there was no further trouble.

The dam for about 40 ft. of its height is of rubble masonry laid in Portland cement mortar mixed 2 to 1. Above this there was facing stone, 30 ins. deep, laid in 2 to 1 Portland cement mortar, backed with rubble in mostly 2 to 1 mortar. The rubble stones varied from a cubic foot to a cubic yard in bulk, and were laid in full beds of mortar. There were no through horizontal joints. Joints were filled with mortar, into which as many stone spalls were forced as was possible. All stone was marked before using. Sand and cement were mixed dry, and then wet only when required. All cement passed through a sieve of 10,000 meshes, and was carefully tested. All loamy sand was rejected. The face stone was a light bluish gray limestone, cut rectangular, with rock face. Stretchers were 3 to 6 ft. long by 30 ins. wide, and headers 4 ft. long. The thickness of courses diminished from the bottom up. The beds were at right angles to the face, and the stone had to be held in place with wooden blocks and wedges, to prevent slipping until the mortar had set, after which the blocking was removed and spaces left were filled with rubble. The dimension stone was brought by rail from Wilmington, Del.

Stone setting was done by the use of the cable, the traveler and derricks. The cable consisted of a 2½-in. steel-wire cable, stretched over and parallel to the dam, and over towers 667 ft. apart, and anchored in the bedrock. On this a trolley ran, which was worked by a double-drum reversible engine. A load of 10 tons would sag the cable 25 ft. with a clearance of 5 ft. above the coping. Most of the excavation was removed, and all material delivered on the wall in this manner. The cost of the cable erected was $3,750. The first cable after 15 months' use parted without warning under a load of 6 tons, the break, in the author's opinion, being probably due to unequal wear at the point where stone and cement were hoisted. The towers were then raised 10 ft., so as to lessen the tension, and a new cable supplied, which lasted until the completion of the work. When the wall had reached a point 31 ft. below the top, the standing derricks were replaced by a traveling derrick, mounted on a 30-ft. trestle and running on a track of 36-ft. gage; a boom 55 ft. long was used with this derrick.

The most serious flood occurred in November, 1889, when 3.8 ins. of rain fell in 18 hours, and 8.7 ins. during the month. In eight hours after the rain had ceased, the water rose to 10 ft. behind the dam, and in 12 hours to 15 ft., and poured over the top of the dam, although both 48-in. pipes were discharging to their full capacity. No serious damage followed, as part of the dam over the channel was kept 4 to 5 ft. lower than the balance of the wall.

The final estimate for the dam and appurtenances was $436,499. The lowest bid received at the letting was $360,980; the highest, $583,315, and the engineers', $540,030. The difference between bid and estimate was due to modifications in the plans.

The dam is water-tight. With 68 ft. of water behind it, no leaks whatever have been found, either through or under the wall, or around the ends. Sweating at the joints appears at points, but not so much as to cause a trickle; and it cannot be seen on a dry day. This very desirable result is due to the excellent materials used, the care in preparing the foundation, thorough cleaning of all stone, care in mixing mortar, breaking of joints horizontally and vertically and close attention by the engineers to every detail. In addition to this the desire on the part of the contractors to do good work, and the existence of a proper relationship between them and the engineers were factors. The contractors were Sullivan, Rider & Dougherty.

The following notice is given in a recent bulletin in regard to the publication of papers of the engineering congress:

While the responses to the circular asking for funds for this purpose have been gratifying in so far as they have been received, it should be stated that only 10% of the members have thus far been heard from. There are, doubtless, a large number who intended to subscribe, but it is very important that there be as little delay as possible, in order that the Board of Direction may know how far it will be safe to go in the important matter of the publication of the proceedings of the congress. Since the circular was sent out about 30 more papers have been promised, and the interest among foreign engineers seems to be constantly increasing. It is absolutely essential in order to prepare for the proper presentation of such papers as are accepted that they shall be put into type as soon as received, and unless the required funds are in sight it may be necessary to stop this work. It is, however, believed that no such alternative need be anticipated.

COMING TECHNICAL MEETINGS.

WISCONSIN POLYTECHNIC SOCIETY.
April 10. Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
April 10. Secy., Waterman Stone, Baird Building.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
April 11. S. W. Spear, E. Buffalo, N. Y., Iron Works.
NORTHWESTERN SOCIETY OF ENGINEERS.
April 11. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
NORTHWEST RAILROAD CLUB.
April 11. Ryan Hotel, St. Paul. Secy., W. D. Crosman.
DENVER SOCIETY OF CIVIL ENGINEERS.
April 11. Secy., F. E. King, Jacobson Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 11. Secy., F. C. Osborn, Case Library Bldg.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
April 12. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
April 12. Secy, F. M Curtis, O. C. R. R., Boston.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
April 18. Secy., F. W. Mowbray, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
April 13. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 14. Secy., D. W. Meeker, St. Paul.
SWEDISH ENGINEERS' CLUB.
April 15. Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
ENGINEERS' CLUB OF PHILADELPHIA.
April 15. 1122 Girard St. Secy., L. F. Rondinella.
COLUMBIAN ENGINEERING SOCIETY.
April 18. Secy., F. W. Hart, Washington, D. C.
WESTERN RAILWAY CLUB.
April 19. Secy., C. F. Street, Rookery Building, Chicago.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 18. Secy., E. H. Clark, Pittsburg.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 19. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
April 19. Secy., Arthur Thacher, Odd Fellows' Building.
BOSTON SOCIETY OF CIVIL ENGINEERS.
April 19. Secy., S. E. Tinkham, 36 Broomfield St.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 19. Informal meeting. Secy., L. V. Carmait, Roanoke, Va.
NEW YORK RAILROAD CLUB.
April 20. "Rules of Interchange of Freight Cars." Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
April 20. Secy., J. F. Wilson, 94 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
April 20. Secy., C. F. Franson, Portland Block.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20. Atlanta, Ga. Secy., F. A. Charplot, Macon, Ga.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
April 21. 201 Washington Building.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
April 28. Secy., C. H. McLeod, Montreal, P. Q.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
May 1. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
May 2. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
May 3. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
May 4. Secy., E. Nelsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
May 5. Secy., E. K. Smoot, 808 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
May 5. Secy., O. Von Geldern, 719 Market St., San Francisco.
MONTANA SOCIETY OF CIVIL ENGINEERS.
May 18. Secy., F. D. Jones, Helena.
CENTRAL RAILWAY CLUB.
May 24. Secy., S. W. Spear, Buffalo, N. Y.

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AND

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers, who fail to receive their papers promptly will notify us without delay.

The results obtained in the operation of the elevated electric railway at the World's Columbian Exposition will be of great interest, for here electricity is to be applied to heavier work than has been before attempted in electric railway operation. The motor cars to be used there have a normal rating of 200 HP., but can be worked to 500 HP. if necessary. This is very far ahead of the power used by the motors on any electric passenger railway. The City & South London Ry. motors are of 100 HP., and the ordinary street car motors, even on heavy cars, rarely develop over 50 or 60 HP. Of course, the big 1,200-HP. electric motors which are being built to haul trains through the Baltimore & Ohio tunnel, at Baltimore, will mark still another and much longer step in advance, but these are not yet in operation.

The power station illustrated and described in this issue seems to be as well equipped as possible to secure high fuel economy. Compound condensing engines direct connected to large size multipolar generators ought to use steam with very high economy. The total capacity of the station is about 6,000 I. HP., or at least 200 HP. of available energy per train to be operated, after allowing for all losses in the station, line, and motors on the car. The number and variation in size of the engines and generators is such that it ought to be possible to adjust the station very closely to the demands made upon it for power. The boiler plant heats its feed water by fuel economizers; and, as it uses oil fuel, there will be no loss of coal in banking fires. In addition the traffic of the road will probably be fairly steady for 9 hours out of the 24, and as there will be no occasion for running any "owl" trains the station can shut down over night. All these things certainly give the engineers of the road great advantages in their attempt to make a low record for fuel consumption.

The resistance of railway trains at high speeds was discussed at length in our issue of June 9, 1892, and the conclusion was reached from all the evidence at present available that the resistance of passenger trains running at full speed on a level may be expressed by the formula:

R (resistance in lbs. per ton) = ¼ V (velocity in miles per hour) + 2.

This gives results much lower than the older formulas, but the evidence supporting it is sufficient to show that, whatever its errors, it is much nearer to the truth than they were.

It is of interest to compare this formula with the results obtained in a series of locomotive tests on the Chicago, Burlington & Quincy, described in a recent paper by Mr. Wm. Forsyth, M. Am. Soc. M. E., before the Western Railway Club (Eng. News, March 16, 1893). These tests were made on trains weighing 300 to 425 lbs. back of the tender, and at speeds of 40 to 60 miles per hour. The average results of the tests were as follows:

Speed, m. p. h.	Resistance, lbs. per ton.	Tons of cars.	Pull on tender draw-bar, lbs.
42.25	13.5	351.5	4,719
49.9	9.7	366.4	3,560
54.6	12.3	336.7	4,143
55.8	11.56	342.0	3,730

The general showing of these results, as expressed by Mr. Forsyth, that at speeds of 40 to 60 miles per hour the train resistance is about 12 lbs. per ton, corresponds fairly well with the formula above, which gives a resistance of 12 lbs. per ton at 40 miles per hour and 17 lbs. per ton at 60 miles per hour.

It will be noticed, however, that the results of the test apparently show greater resistance at the lower speeds than at the higher. Mr. Forsyth explains this anomalous result by saying that at the lower speeds, although the speed was apparently uniform, it is probable that the locomotive was really accelerating the train, while at the higher speeds the engine had reached a point where further acceleration of the very heavy train was difficult or impossible, and, in fact, there may have been a slight falling off of the speed, which would reduce the apparent resistance as measured by the dynamometer. Mr. Forsyth's tests were made at different times during two months or more; and variations in the temperature of the air, and in the side or head winds, on different days, and even on different portions of the same trip may also help to account for the variations noted in tests made on trains of the same weight at speeds supposed to be the same.

For these reasons the general results of the tests are to be accepted as reliable rather than the minor variations, which show on the face a decrease of resistance with an increase of speed. To summarize, then, Mr. Forsyth's tests furnish additional evidence that train resistance at high speeds is much less than has generally been supposed; and that the formula $R = \frac{1}{4} V + 2$ is approximately correct. In so far as the detailed results of Mr. Forsyth's tests are to be accepted as accurate, they show that within the range covered by the tests, say 40 to 55 miles per hour, the resistance is somewhat more uniform and somewhat lower than that given by the formula.

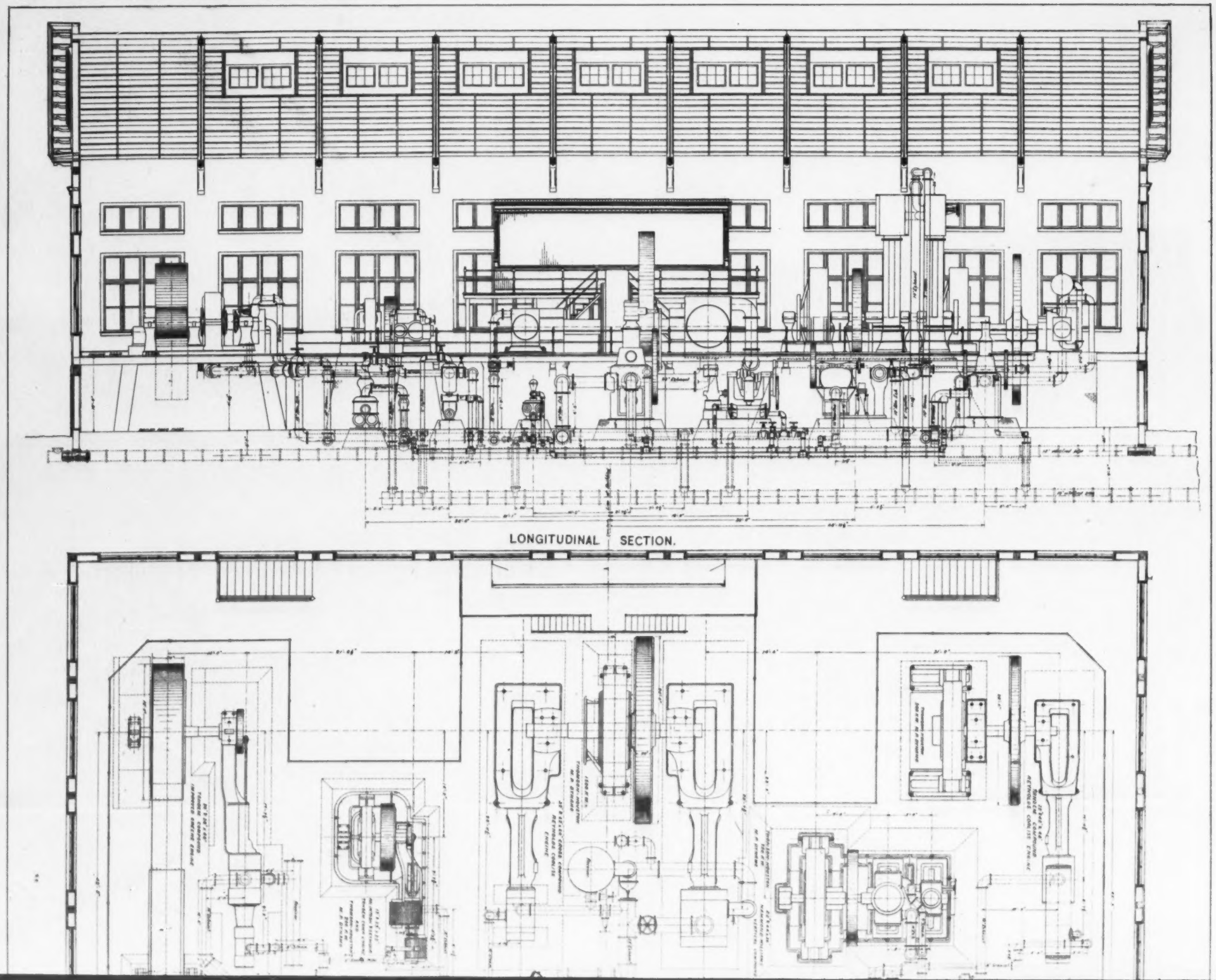
The very numerous and serious fires which have occurred recently in the power stations of electric railways are likely to have a serious effect in advancing insurance rates on such property, which were already very high. A still more injurious effect is likely to be an increased public distrust of electricity generally as an incendiary agent. The facts seem to be that in all the electric street car fires which have occurred, the cause of the fire has been not at all difficult of explanation. For example, in the most recent fire of this sort, that which destroyed a station and cars worth $100,000 at Newark, N. J., on April 3, the night watchman discovered flames issuing from the oil house in the back part of the building, and so inflammable was the material before them that the whole building and its contents were blazing by the time the fire company, a few blocks away, reached the scene.

To locate an oil house inside a car barn in such a position was to deliberately invite the destruction which resulted. Experience is a dear teacher, but between her instruction and the heavy tax assessed by the insurance companies it will eventually be realized that slow burning or fireproof construction is by far the cheapest method of building power stations. It must be borne in mind, however, that a car barn, built of absolutely fireproof material and filled with cars is far from being exempt from the danger of fire loss. The varnished surface of a car body is admirably adapted to spread the flames, and if they once obtain full headway in a crowded car house it makes little difference with the destruction whether the walls and roof of the building are combustible or not. This being the case, it is self-evident that the way to protect the car barn is first to prevent the entry of fire to it, and next to provide means for putting out any fire at its start. The car barn should preferably not be located in the same building as the engines and dynamos; but if other reasons make this necessary, then good solid fire-resisting walls or floors should separate the car barn from all other portions of the plant. Add to this a thorough system of automatic sprinklers, supplemented by other approved fire extinguishing appliances, and the rolling stock of an electric railway will be a reasonably safe risk. We may suggest in addition that the plan adopted by Mr. B. J. Arnold, at the Little Rock, Ark., power house of putting the tracks in the car barn in a grade, so that by merely loosening the brakes the cars will roll into the street, is a point worth attention by those engaged in the design of such structures.

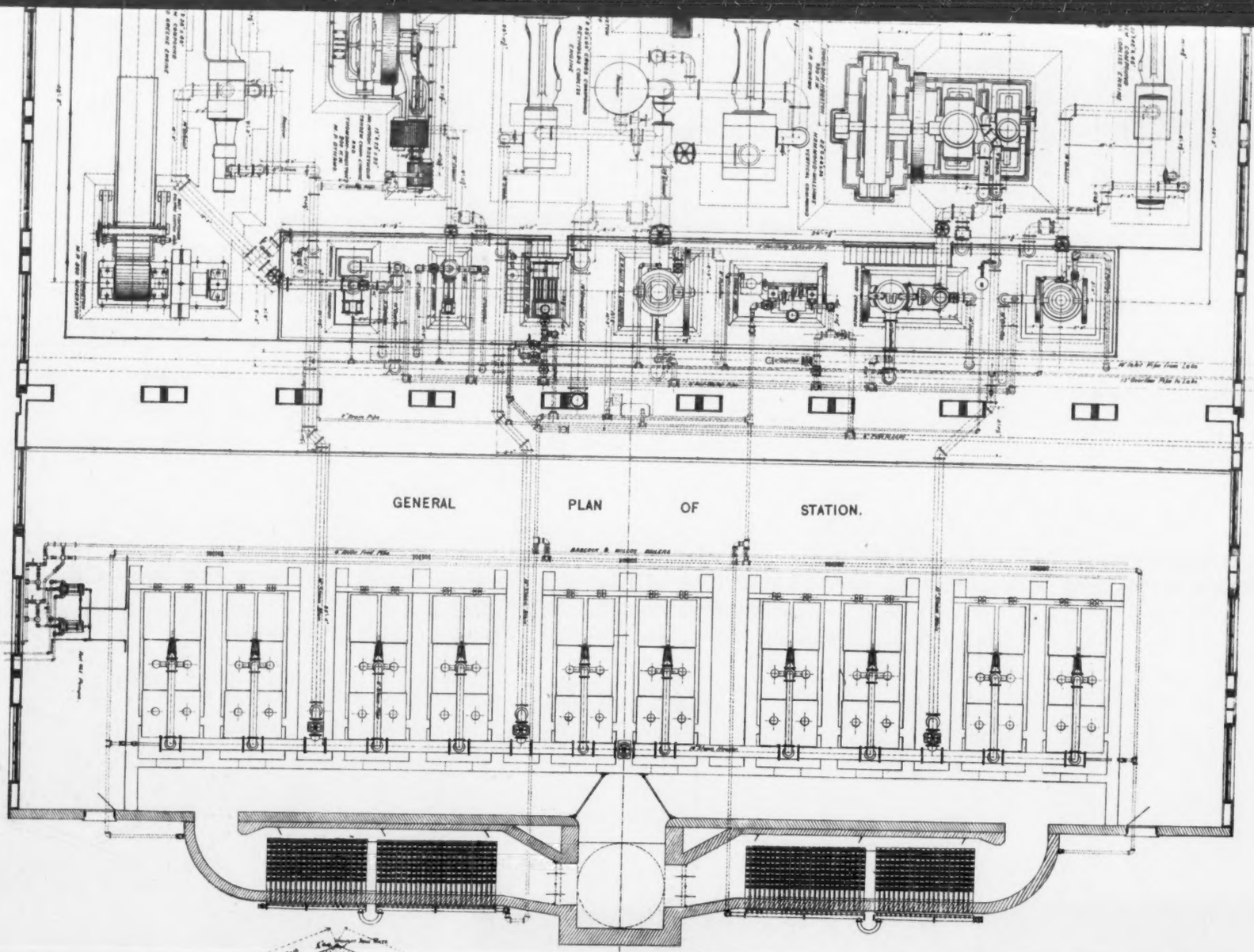
The memorial which is to be presented to the next Congress, favoring the formation of a Department of Roads, in Washington, somewhat similar to the existing Department of Agriculture, bears proof to the earnest, untiring and patriotic efforts of Col. A. A. Pope and his friends in this work. As far as this memorial refers to a comprehensive road exhibit at the Chicago Exposition, we would heartily favor it did time now permit any action on that head. But as Congress failed to pass the bill of last July, appropriating $100,000 for this purpose, little more will be done than what has already been provided for by the Department of Agriculture, in tests of traction on various roads and pavements, etc.

But as we have before said, we cannot see what benefit is to be derived from the addition to our national government of a special department whose duty it shall be to care for the highways of this country. A bureau in the Department of Agriculture might do good work in gathering, compiling and publishing statistics; but we do not believe in a national control of highway construction any more than we do in a similar control of railways, water-works, gas-works, or any other public work which serves a special district or community. Such centralization of control is not in accordance with our present state organization, which now vests all authority over local enterprises in the state governments; and an attempt to place in the hands of a national department located at Washington the planning and construction of state, county and township roads will inevitably lead to confusion and to a conflict of authority. We stand upon an entirely different footing in this respect from the often-quoted countries of Europe; and the rules that can and do apply there will not fit our organization at all.

We heartily favor the crusade for good roads, so far as the work planned and accomplished in this direction tends to educate the people up to the proper appreciation of well constructed and well maintained highways and puts a stop to ancient, inefficient and wasteful expenditures of money in road-tax labor and undirected, unscientific effort. But this education should properly proceed from state, county and township centers, and be guided by local needs and local resources. Good roads cost money to build and money to maintain in proper order; and unless there is a direct demand for the improved roads in proportion to this cost they will not be built. Road improvement does now and will continue to proceed from central points, where proximity to large towns or cities increases traffic and makes good roads a necessity and an attraction to suburban population, and thus enhances the value of adjoining lands. It is nonsense to claim, as some have done, that because the excellent highways of Union County, New Jersey, have doubled the average value of farm lands in that county that a similar result would follow in a section remote from large masses of population. The traffic demands will generally control the amount of attention bestowed upon road construction in any locality; and in proof of this we have the fact that the chief highways in the eastern states were in a much better condition 50 years ago than they are now. Railways have taken from these roads the heavy freight and all the longer distance travel; and they have fallen



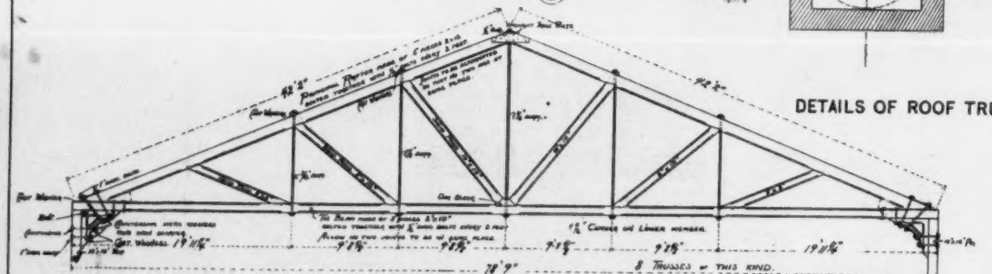
LONGITUDINAL SECTION.

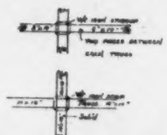


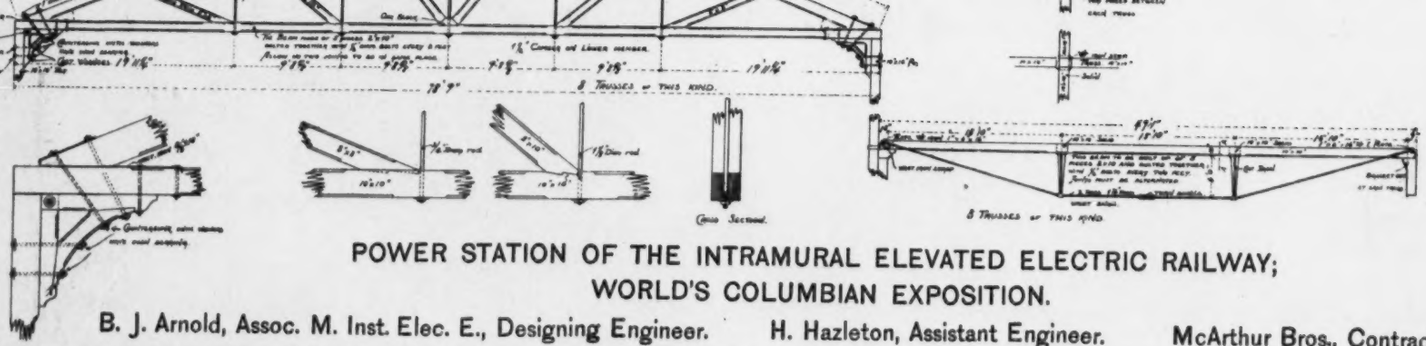
GENERAL PLAN OF STATION.

0' 5' 10' 15' 20'

DETAILS OF ROOF TRUSSES.



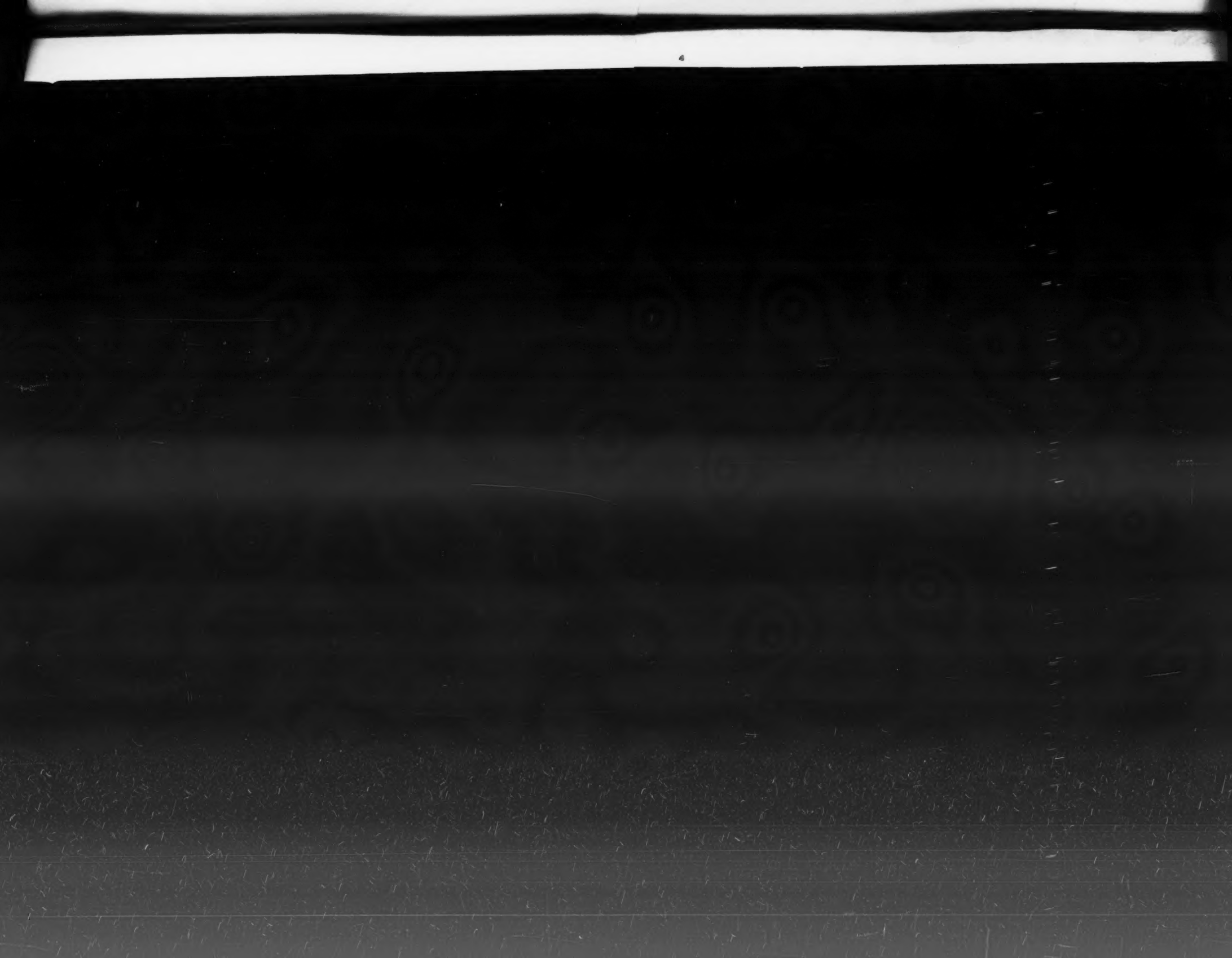




POWER STATION OF THE INTRAMURAL ELEVATED ELECTRIC RAILWAY; WORLD'S COLUMBIAN EXPOSITION.

B. J. Arnold, Assoc. M. Inst. Elec. E., Designing Engineer. H. Hazleton, Assistant Engineer. McArthur Bros., Contractors for Building.

CHAS. HART & SONS, LITH, 20 VESEY ST., N. Y.



into decay simply because the traffic left them is not important enough to pay for their maintenance. It is true that many of the roads are shamefully neglected; and where some semblance of repairs is kept up it is by the utterly wasteful, useless method of allowing a farmer to work out a road-tax, and this should be corrected as soon as possible. But what is wanted is not a national department, but a strong and intelligent local effort to improve upon existing bad practice. A highway commission for each state, with sub-committees in each county, made up of men who are earnest, and know the individual means that they can control, will do the greatest permanent good. From these men, and not from Washington, must come the laws that will define the methods of work best suited to the community; and from these men and their neighbors must come the money expended in road improvement.

PUTTING ELECTRIC WIRES UNDERGROUND.

The conveniences which electricity has brought to every man's door during the past two decades have been accompanied by some inconveniences, which have generally been accepted as inevitable. In nearly every American city large enough to really deserve the name, telephone, telegraph, district messenger and burglar alarm service and electric lights are available for those who can pay for them; the streets are lighted and fire alarms are rung by electricity, and there is more or less distribution of electric current to drive motors. Nearly all this service is still given by means of wires strung on poles; and the nuisances and dangers of these overhead wires are an old and oft-told story. In several of the largest cities of the country more or less has been done in putting these wires underground; but it has been done amid such a wrangle between the electrical companies and the city authorities, and there have been such conflicting reports of successes and failures, and so many expert "couldn't be done's" and "could be done's," that outside those who have given some special study to the question there are very few who have any clear idea as to what is the real status of the underground wire problem at present. Probably the general opinion of most engineers and electricians on this topic was well expressed by a member of the National Electric Light Association at the recent St. Louis convention, who said that underground wires positively could not be afforded in any city of less than 250,000 inhabitants. Another member expressed very well the attitude of the electric lighting companies on the question by saying that the companies had invested their money in poles and overhead wires, and they were not going underground with their circuits until they were obliged to.

Clearly under these circumstances, the initial movement toward placing wires underground must be made generally by the city authorities themselves and we believe many of our readers who occupy official positions will find the statements in another column concerning the results of experience with New York City's electrical subways of no small practical value.

Some points which are brought out in this record deserve especial emphasis. In the first place, our contractor and civil engineer readers should understand that there is nothing more mysterious or difficult about laying an electrical subway than there is about laying a water main; and any contractor or engineer who can figure the cost of one can figure the cost of the other. The type of electrical subway which is principally used and has been most successful in New York city consists merely of a number of wrought iron tubes, from 2 to 4 ins. in diameter, laid in a trench and surrounded by concrete. The number and diameter of the tubes depend upon the number of wires to be accommodated, but as a rough guide it may be said that one 3-in. tube will accommodate 200 or more telegraph, telephone or messenger wires, or a half-dozen high-tension electric light wires. In general the telephone wires and others worked from a battery should be placed on the opposide side of the street from wires used for electric light or power circuits, or at least the tubes containing the two kinds of wires should be kept as far as possible from each other. Manholes to give access to the wires for making service connections and to permit the cables to be drawn into the tubes must be placed at intervals of 200 to 500 ft.

With these particulars any engineer can make a rough estimate of the cost of electrical subway construction, and will find that the result is by no means the extravagant figure which is generally supposed. We do not mean by this that any engineer is competent to make detailed designs for a system of electrical subways. An able electrical engineer is certainly needed for this, and his employment will be money saved. But given the complete designs and specifications, an engineer or contractor accustomed to city work can figure very closely on the cost of the pipe, concrete, trenching and manholes which are required.

The cost of New York city's electrical subways per duct per mile has been given as about $3,000. But it must be remembered that the cost of such work in New York city is higher than it would be, or ought to be, in most other cities. Besides this, the New York subway companies have spent considerable money in experimental work, and in view of the risks and uncertainty attending the enterprise at the outset, those investing in it have rightly received heavy returns on their capital invested. Thus, the fact that the New York electric lighting companies regard their subway rentals as a burden grievous to be borne does not prove that the cost of subways is such as to make them out of the question, even in small cities.

Mr. Wm. H. Browne, in a recent paper states that, with the benefits of the experience which has accumulated since the New York subways were begun, the accommodations of the New York electric lighting companies could be duplicated at 25% of their cost. Really there is no reason, now that we know that insulation is not a necessary duty of an electrical subway, why the cost of putting wires underground should be anything appalling, even in the very small cities or in scattered suburban towns.

For example, let us, as an extreme case, estimate the cost of a subway on a residence street, where the number of customers is so small that one 3-in. duct on one side suffices for electric light wires, and a 2-in. duct on the other accommodates all the telephone, messenger and other wires. Let us suppose, also, that 12 manholes on each subway can be made to suffice. We have then:

1 mile of 3-in. pipe, at 38 cts. per ft., 70% dis...	$602
1 mile of 2-in. pipe at 25 cts. per ft., 70% dis...	396
2 miles of concrete, net section 22 sq. ins., at $8 per cu. yd.	480
24 manholes at $25.	600
Trenching, backfilling, and laying concrete.	350
Total.	$2,428

Thus the first cost of the subways necessary to accommodate the overhead wires on a purely residence street may be set at $2,500 per mile, or, roughly, 25 cts. per foot of frontage on each side of the street. This means for every 50 ft. frontage a first-cost charge of $12.50. But to allow for vacant lots, streets, and houses which do not take electric service, let us suppose that only one-eighth of the frontage belongs to houses which take electric service of some kind or other. Then the first cost charge to each house of 50 ft. front will be $100, and reckoning interest and depreciation together at 8% this means that if the users of telephones, electric lights, etc, have to pay the whole of the increase in cost of the electrical service due to the cost of building the subways, it will add $8 to the annual bills of each patron of the electric service owning 50 ft. frontage. In the days which are certainly coming when all forms of electric service will be much cheaper than at present, and the house with no electric lights will be the exception, this figure will be considerably reduced.

But is it just that the whole charge for the electrical subways should fall on the customers of the electrical companies? Do not the companies themselves reap enough benefit from the subways to make them in equity bound to bear part or all of their cost, and without increasing their charges? Mr. Wm. Maver, Jr., whose experience as electrician for the New York electrical subways makes him an authority in these matters, estimates the average total cost of maintenance of well constructed and well managed electric light underground cables at $5 to $8 per mile per annum. The cost of maintenance of overhead wires he sets at $18 per mile. But in addition to the actual cost of maintenance there is the rental for roof privileges, renewals of the poles once in 8 or 10 years, the damage caused by interruption of service by heavy wind and sleet storms and the damage to machinery, burning out of armatures, interruption of service, etc., by breaks, crosses, grounds and lightning. Damages to linemen and others falling from poles or injured or killed by high voltage currents from overhead wires must also be considered.

To sum up in a nutshell, the wires in the subways can be operated the year round with safety, and certainly, while overhead wires are a continual source of interruptions and troubles, Mr. Maver mentions one New York electric lighting company, operating over 25 miles of underground cables, which has not had for over a year a single occasion to shut down on account of trouble in the underground conductors, and has not expended one penny during that time for "patrol" or repairs.

The immense value of this feature of absolute reliability in an electric service is bound to be better appreciated. It is well known that in all the first installations of electric light apparatus the gas fixtures were retained in place, and the occasions when their use were required were by no means infrequent. But with underground conductors there is no reason why a consumer's supply of electric current should not be as reliable as his supply of water. The increasing use of motors taking their current from a central station is further emphasizing the need of reliability, and electrical companies are coming to appreciate this fact.

Taking all these things into consideration, it seems not unlikely that in the long run an electric lighting company will find it for its own advantage to place its wires underground at the start. And even if for a few years it has to slightly increase its rates for service to cover fixed charges on its original investment, it is certain that the amount of this increase cannot justly be made very considerable.

It is worth while noting further that if electrical subways can be built at a reasonable figure, the way is open to an excellent solution of the widely agitated problem as to the municipal control of electric lighting companies. It is generally conceded that one advantage of municipal ownership and operation of electric lighting plants is that the duplication of overhead wires by competing companies is avoided. On the other hand it is agreed that the average municipal government will manage an electric lighting plant less efficiently than the directors of the average corporation.

As a compromise between these plans, a city might build for itself a complete system of electrical subways, and then grant to the bidder offering the highest percentage of gross receipts the sole right to use these subways and furnish electrical service at fixed rates for a term of years. In this way the city would retain control of its streets, and would do away with overhead wires at the least cost to users of telephone and electric lights. The electrical company purchasing such a franchise would be secure from damage by storms, through the protection afforded by the subways, and would be secured from the cut-throat competition of new companies by its contract with the city. Under these circumstances it could well afford to pay a considerable percentage of its gross receipts to the city and still be certain of a handsome return on its investment.

RAILWAY MANAGEMENT IN INDIA.

In the construction of the railways in India the English engineers have shown great lack of comprehension of economic principles and lack of adaptability to local conditions, as pointed out in an article on "English Railway Practice in India and the Colonies" in our issue of Aug. 4, 1892. The present management of the railways shows the same characteristics. Gen. J. F. Fischer, Royal Engineers, whose views on this matter were set forth in an article on "Railways and Hydraulic Works in India" in our issue of Dec. 22, 1892, has recently made the following statement in a letter to "Indian Engineering," in which he shows that agriculture is the great industry of the country:

> In agriculture it is absolutely necessary to have the cheapest means of transport possible to make its raw products of the greatest value in the markets, and so we establish railways carrying heavy goods (freight)

traffic at $3 a ton a year (whatever that expression may be supposed to mean; it seems to us to mean nothing.—Ed.), while in America they do the same work at ten times the speed for a little over 25 cts. a ton a year, and have constructed their double lines on the standard gage at much less cost than we have made single narrow gage lines in India, with labor costing ten times as much as it does here, and all other materials, excepting iron, of course, costing in proportion.

These results are due mainly to the reasons above given, and to the consequent extravagant tendency of the engineers to construct great and monumental works, not only without regard to the financial conditions of the country or of the traffic, but (what has really done as much as the other to increase the cost improperly) without due study of the topography and skill in adapting the lines thereto, so that the final result is a needlessly costly line for any traffic whatsoever. Davidson, in his "Railways of India," says that it was originally thought that the railways could be built for $25,000 per mile, and proposals at $40,000 per mile were rejected, while in fact the cost per mile has been from $50,000 to $100,000. This is partly accounted for in regard to the early railways by the difficulties encountered in first enterprises of this kind, and to the necessity of procuring nearly all the materials from England. Davidson himself admits the tendency to the construction of great and notable works rather than to the exercise of economy, but says that this tendency was not displayed on the works of the first railways. In fact, he instances one case where an engineer, after careful study of a river crossing, reduced the number of spans from 15 to 14, effecting a saving of some $80,000, but such cases we judge to be remarkable for their infrequency. On the other hand, Mr. R. F. Fairlie, the well known advocate of the narrow gage system, writing in 1872, said that the Indian railways had been made too magnificent, and that the comparatively short mileage had been built at a stupendous outlay, to accommodate a very small traffic. The same conditions, he said, also existed in Australia.

Government ownership and military control appear also to be factors in causing the great expense of construction and management, as the state railways appear to show the worst results. The uneconomical management of the purchase of material and supplies in England for the Indian state railways is a constant source of complaint in India. Requisitions or "indents" for materials required are sent in, forwarded to the India Office (England), contracts let with much red tape formality (without much real competition apparently), and then the delivery of the materials is delayed for several months, and the materials themselves are not infrequently found to be different from those actually required. The following abstract of an article in "The Indian Engineer" sets forth the case very clearly, and shows what the East Indian Railway Co. can do the government could do if it chose, to the benefit of the railways and of the country generally:

The receipt, from the Director-General of Railways, of an abstract of recent prices paid by the India Office for the principal kinds of material required for Indian railway construction and maintenance affords fitting opportunity for reiteration of views consistently urged in these columns in favor of the encouragement of manufacturing industries in this country in every possible way. It appears that in the quarter ended Sept. 30, 1892, there were contracted for by the India Office above 1,500 tons of steel and iron bridgework, comprising plate girders from 6 ft. to 80-ft. span, triangulated girders from 60 ft. to 100-ft. span, and Whipple-Murphy trusses from 100 ft. to 300-ft span. A rough average of the prices paid for girders up to 100 ft. span would seem to be about $52.50 per ton, while freight came to $7.50 per ton. The larger trusses appear to have cost about $60 per ton, the freight being the same as before. Bridgework representing some £20,000 sterling ($100,000), must have been contracted for during the quarter. The abstract contains various items, comprising bridgework, engineer's plant, workshop machinery, track materials, car and locomotive stock, station materials and fencing, and tools and stores, many being of special character and unprocurable in this country; but we notice several items, in addition to the bridgework, which could have been supplied from local sources. We may instance cars, cast iron pipes, roof ironwork and galvanized sheeting, and wrought iron tanks, for the out-turn of all of which there exist abundant facilities, while tools, steel and bar, angle and sheet iron and cement are kept largely in stock by local engineering works. We should like to compare the prices paid by the Stores Department of the India Office for the articles we have enumerated with those which would be charged by Indian manufacturing engineers for similar articles; but, unfortunately, we are not in a position to do so, and must therefore sustain on general grounds the argument that no material or manufactured article for use on state railways should be requisitioned for through the India Office while similar material or articles can be supplied locally of equal quality and not exceeding the same cost. In the interest of the manufacturing engineers themselves; in the interests of the many thousands of workmen whose employment in industrial pursuits would open up a field of usefulness, the importance of which cannot be over-estimated; in the interest of the government of India, and of the general welfare of the country, which would enjoy a greater degree of independence than at present obtains; and in the interest of the railways themselves, who would save time in the execution of requisitions, and have the advantage of being able to superintended the process of manufacture—this course is imperatively necessary. We are aware that some relaxation has been made in the government rules which provide for requisitions upon the Secretary of State, but much yet remains to be done; and the sooner it is done, the better.

We observe from the abstract that while the India Office takes from 7 to 16 months to comply with requisitions for different descriptions of bridgework, the average time which usually elapses between date of indent and receipt in India of articles of engineers' plant and workshop machinery is six months. As these comprise blocks, boilers, cranes, engines, forges, fans, jacks, pumps, ropes, winches, blowers, lathes and other machines of stock patterns, it is difficult to imagine how one-half of the time is occupied. Any private firm possessing a telegraph code would, we imagine, be glad to undertake the supply of stock articles in two months under a penalty, and why four months should be wasted in order to furnish an excuse for the existence of a cumbersome and red-tape-tied department is a complete mystery. Apart from such question as the saving of time, the other interests involved demand speedy revolution of the present method. The spread of technical education is resulting in the training of a large number of artisans to useful pursuits; and if the operations of local firms of manufacturers are to be restricted, as is at present the case, it is difficult to see how such workmen are to be provided for. The question of the development of our mineral resources is also involved, and it is hardly likely that pioneers will come forward unless they are assured a certain measure of government support. The East Indian Railway is setting a good example in this direction; and by taking advantage of the proximity of the Burrakar ironworks, and the excellent quality of pig-iron they afford, and by increasing the capabilities of the rolling mills at Jamalpur, the undertaking is no longer dependent upon England for metal ties, or for bar or rod-iron of ordinary sections. If government would take a leaf out of the East India Railway book, and make itself as independent of India Office supplies as it possibly can by the encouragement of local manufacturing industries, it would not only strengthen its own position, but would give a stimulus to important industries which can only tend to improvement of the trade and well-being of the Indian empire.

The railway equipment and train service are unsatisfactory in many ways, owing to the attempt to follow English practice as closely as possible, and, as we have before stated, in comparing American and colonial railways, it would be good policy for Indian railways to obtain information as to American practice, which is admittedly the most economical for new countries, although English engineers and railway men are only now beginning to see that American principles are equally applicable to the efficient and economical operation of established railways with heavy traffic. Canada has long ago abandoned English precedents, and has her railways and railway equipment exclusively on the American system, and some of the other colonies are now beginning to introduce American ideas, the disadvantages of the English system being so evident. Railways have been a great boon to India by extending civilization, developing industries, and facilitating the rule of the military government. But they are also proving to be a rather heavy burden under the existing conditions, and complaints are frequent as to the extravagance and inefficiency in management. Mr. Rudyard Kipling, in one of his ballads, lightly but sharply satirizes the practice of putting the Indian railways in charge of a "colonel" from England, who knows nothing about railways.

It was first estimated that the railways could be built in India for $25,000 per mile, and proposals at the rate of $40,000 to $45,000 by an English contractor were therefore rejected, but even this rate has been largely exceeded in the actual cost. For the first railway in India, that from Calcutta to the coal mines at Raneegunge, 121 miles, the engineer's estimate was $33,365 per mile of single track, but his adherence to costly English practice is shown by the fact that he proposed to use 84-lb. double-headed rails in joint and intermediate chairs weighing 38 and 21 lbs. each. Later, however, 65 and 75-lb. rails were used, and the more economical flat-bottomed T-section was also introduced, the present standard rail of the Indian State railways being a 75-lb. T-rail (Eng. News, Dec. 29, 1892). In the United States the cost of railway construction was estimated as follows in 1856; Prairie lines, $15,000; in rolling country, $20,000; in mountainous country, $45,000 per mile for single track, and including equipment. In 1894 the contract for sections of what is now the Scinde, Punjab & Delhi Ry., of India, was let to English contractors for a lump sum at about $75,000 per mile, including equipment, the road to be finished in five years. The cost per mile of the earlier Indian railways previous to 1868 (all 5 ft. 6 ins. gage) ranged as follows:

Railway.	Cost per mile.
East Indian, single track	$75,000
" " double "	110,000
Great India Peninsular, single track	70,000
" " " double "	100,000
Bombay & Baroda, single track	100,000
Scinde, "	95,000
Eastern Bengal, "	85,000
Madras, "	60,000
Punjab, "	50,000
Great Southern, "	38,500

Russia, whose advances in Central Asia are a constant menace to India, has taken lessons from American practice. The Trans-Siberian Ry., built mainly for strategic purposes, has been constructed with a view to opening communications as fast as possible, leaving improvements and increase in stability to follow. The engineers who made surveys for this line were directed to cross from the eastern terminus of the line to the United States, and to make a careful study of railway practice and conditions in this country. That Russia is alive to the importance of communications was shown during the Russo-Turkish war, when mountain roads were rapidly built, and traction engines and portable railways were used for the handling of troops and munitions of war. Lord Dalhousie, Governor-General of India, in 1854 urged the immense importance for strategic purposes, as well as for commerce and the general good of the country, of a railway from Calcutta northeast to the frontier, by which the regular changes of troops between the different military stations could be effected in a few days, instead of in weeks or months of marching through a difficult, and in some places, unhealthy country. There are railways to the frontier now, one of which, the Bolan Ry., was noted in our issue of March 23, but, judging from the present conditions, it seems probable that when Russia does move on the frontier the government and the military and railway authorities will find great difficulty in keeping up the communications and in the efficient mobilization of troops to cope with an invader who knows something about mountain engineering work and is not, like the English, hampered with questions of precedent.

The best metal for brake shoes is one of the subjects on which a report is to be made at the next M. C. B. convention, and as the committee appointed has not undertaken the work, statistics on the subject are being collected by Secretary J. W. Cloud.

Besides the Brown wire-wound gun, described and illustrated in our issue of Nov. 24, 1892, two other wire-wound cannon are in process of manufacture in this country, and are expected to be ready for test some time next month. A 10-in. gun designed by Dr. W. E. Woodbridge has been built at the Watertown Arsenal and is now receiving its breech mechanism at the Watervliet gun factory. Another 10-in. rifle nearly completed at the Watertown Arsenal is the Crozier wire-bound gun, designed by an officer of the Ordnance Department of the Army. Evidently the wire-winding system of cannon making is to be given a fair show, something which it is claimed never to have had in foreign tests.

A new line of lake steamers to ply between Oswego and Duluth is to be put in operation by the New York, Ontario & Western Ry., and the vessels have already been chartered.

LETTERS TO THE EDITOR.

THE NIAGARA FALLS TURBINES.

Sir: It does, indeed, seem rather a pity that when the greatest hydraulic power plant ever undertaken is carried out in this country, the designs and working drawings for the machinery should be made by foreign engineers.

For all ordinary water powers, American turbines long ago proved their practical superiority to the best work of foreign engineers; and it is rather surprising that the turbines for this plant of world-wide fame should have to be designed by a firm of Swiss engineers. However, as only two out of the fourteen designs which were submitted to the International Commission were prepared by American firms, it is not quite fair to conclude that no American engineer has the ability to cope with such a problem as that at Niagara Falls. It may be that the American engineers who could have done as good or better work than Messrs. Faesch & Piccard, are too busy to enter competitions; or, perhaps, they took it for granted that the simple and efficient Pelton wheel, which has proven its value so thoroughly under exactly the conditions presented at Niagara, would have so great practical advantages that no form of turbine would stand any show. Whatever the reason may be, our hydraulic engineers of greatest experience and ability made no attempt to solve the Niagara problem; the International Commission, or the Cataract Construction Co., were inclined to look rather doubtfully on the Pelton wheel; and so the designs of a Swiss firm were accepted.

The drawings of the Swiss turbines which you published in your issue of March 30 show many commendable features; and yet I must confess that I find them somewhat disappointing, perhaps because I was expecting that some remarkably perfect machines would be the result of that international competition. I have understood that the Pelton Wheel Co. offered to guarantee an 80% efficiency for their wheel; and its advantages of simplicity, accessibility, ease of repair and small first cost are generally admitted. So when it was stated that a Swiss turbine had been chosen instead, I supposed that it must possess marked advantages, and be a decided departure from any turbine in existence. Thus, you see, I was quite prepared to give Messrs. Faesch & Piccard full credit for all the ingenuity and engineering ability displayed in their designs; and I do this with pleasure. Certainly their turbine is the work of no 'prentice hand. At the same time, I wish to exercise the right of every free American to find fault. I am disappointed, in the first place, with their arrangements for securing efficiency. When the Pelton wheel, with its probable efficiency of at least 80%, was discarded, I supposed some motor with at least 85% efficiency would be chosen in its place; but as near as one can judge from Messrs. Faesch & Piccard's drawings, 80% at full load will be as good an efficiency as can possibly be expected, and very much less than this at the ordinary load of, say, 75%. The plan adopted by Messrs. Faesch & Piccard of increasing the efficiency at partial loads by dividing the turbine horizontally, so that the one wheel becomes practically three wheels, is an ingenious one; but why did not its author carry it farther? As now arranged, the turbine will work at its best efficiency when it has either full load, two-thirds load, or one-third load. It seems reasonable to believe from what is now known, that these turbines will usually be run at about three-fourths load, and will be run but little at less than 40% of their rated load. Thus, to secure the greatest efficiency in these turbines the wheels should not be divided into three equal parts, but in the proportions of, say, 40, 40 and 20. Then, under ordinary loads the water would escape freely from two sets of openings, larger than those in the other wheel, and so having less frictional loss.

The method of regulation adopted, throttling the escaping water, has the advantage of simplicity, but is, of course, a wasteful system. It seems as if some system of regulation by adjusting the guide passages, not too complicated to be practicable, might have been devised. Apparently the designers have sacrificed efficiency wherever necessary to obtain close regulation of speed; but notwithstanding this, the rate of regulation which it is claimed will be secured, seems to me disappointingly sluggish. If only 25% fall in the load causes a 3% or 4% jump in the speed, there is certainly considerable to be desired in the governor and its appendages.

For these reasons, and others which I will not take your space to state, I am disposed to believe that some American engineers, if they had chosen to attempt the task, could have designed turbines quite as good as those of Messrs. Faesch & Piccard.

Very truly yours,

New York, April 3, 1893. "Hydraulic."

SEWERS AND DRAINS.

Sir: In suggesting the need of more exactness in the use of the words "sewer" and "drain," I hoped by quoting from good authority to emphasize the fact that the sewer must be in common use by more than one piece of property in order to be so designated; and that the use of the words "house sewer" is radically wrong, being contrary to the prevailing idea that a sewer must be in common use by several individuals. Any person looking over the very carefully drawn Act of Parliament to which I referred, will be impressed with the belief that the definitions there given were not carelessly worded, and that they represent the best English usage.

We cannot start an entirely new set of definitions, as Mr. Stearns proposes, without doing a most arbitrary act of violence to the language. I would suggest that this difficulty as to house-drainage nomenclature may be relieved by referring to the house-drain for sewage, the house-drain for subsoil water, or the house-drain for rain water, as the case may be, if there are independent drains for these different uses. The public sewer will then carry the polluted water from the houses, either separated or with the storm water. If there is a separate conduit for storm water, it is a question whether it should be called a common sewer or drain. In view of the fact that its effluent will be nearly as polluted as ordinary house sewage in many cases, it might properly be termed a storm-water or rain-water sewer. The common subsoil drain could be called the public or common drain.

I am very truly yours,

Horace Andrews.

Albany, N. Y., March 11, 1893. City Engineer.

(There is some force in the argument of Mr. Andrews, and his use of the word "sewer" would agree with the long-accepted definition that it is a public conveyor of refuse liquids from several premises. To apply the word sewer to an individual carrier of liquid refuse from a single property is likely to cause some confusion, we admit. But this house sewer may be an important channel, if it comes from a large hotel, hospital or apartment house, and convey quite as much sewage as many street sewers proper. As long as the two terms of sewer and drain are applied to different parts of the same general system of sewerage, there will be some danger of confounding them, as is the case now. It was for this reason mainly that we last suggested that the word drain be eliminated entirely, as a carrier of liquid filth, even at the risk of doing some violence to the language, and that the function of the special sewer be designated by some prefix establishing beyond all doubt its special use. We know this is a difficult task to undertake, but if a change is to be made, it might as well be a radical one.—Ed.)

BRIDGE CONTRACTS.

Sir: The recent discussion in Engineering News on the evils of the present system of bridge lettings is a step in the right direction, and indicates that at least a few are anxious for reform. Thus far, attention has been confined to the consideration of highway bridges, for the reason, no doubt, of the much larger opportunities afforded for "working" the commissioners or councilmen than obtain with most railway companies. But that the same spirit pervades both branches of the business, to a certain extent, will be apparent from the following bit of the writer's personal experience:

Not very long ago, while in the employ of one of the most thoroughly advertised and presumably one of the most reputable bridge and general contracting companies in the country, it became my duty to make designs and estimates for a certain important bridge for one of the great Western lines of railway.

The bridge, which was of the cantilever type, was to be designed under Cooper's specifications, "Extra Heavy, A."

The bridge company was very anxious to secure the contract, but was afraid that certain other companies would, by their superior advantages, be able to underbid it. At this juncture, one of the engineers(?) of the company proposed that I should cut the specifications 15%, on the supposition that the railway would employ no inspector on the work, and there would be consequently very little probability of being found out.

It was only on proving it to be a very bad stroke of policy, not from any moral considerations, that he was finally dissuaded from the plan. The railway company in question, curiously and fortunately enough, had a report made, about this time, on some Howe truss bridges, which the bridge company had built the previous year on one of its branch lines.

As a result of this report, the bridge company was informed that it would not be allowed to bid on any more work for that railroad company.

The fact that the bridge company, in this case, was prevented from carrying out its underhand schemes does not vitiate the argument; but so long as contracting concerns are run for money consideration and not for benevolent purposes, just so long will there be underhand work when opportunity offers. What, then, is the cure for the evil? Evidently the destruction of the opportunity, by providing that all work which affects the public be subjected to the scrutiny of government experts. These experts to be appointed through rigid examination in their specialties, to be required to give a bond for the faithful performance of their duties and to hold office for life or during good behavior.

A board of these experts, which should be entirely divorced from political manipulation, should be required to investigate all accidents connected with public works, and to fix, if possible, the responsibility for the same.

Yours very truly,

Topeka, Kan., March 23, 1893. J. Fred. Temple.

Sir: It is an undisputed fact that bridge manufacturers and contractors building highway bridges, prefer and desire that reputable engineers be employed by the parties for whom such bridges are built, and it is to be lamented that county authorities do not more often see the necessity of employing proper engineers for the purpose of supervising the construction of their bridge work. This would shut out certain irresponsible competition which the better class of bridge builders are forced to meet under the ordinary method of letting highway bridges.

However, a few remarks by an "Agent," or one of "the Boys," who has attended a few hundred highway lettings, upon the "ethics" of a consulting engineer employed by authorities paying for highway structures, may not come amiss, as it sometimes happens that a wise man can learn something from an inferior.

A few engineers labor under the idea that they must not only make plans and specifications, but must also dictate the price at which the contractor must be willing to build the bridge. This happens to be all right when it is done in a fair way, and an estimate of cost is allowed which will leave the contractor a fair margin of profit over and above the cost of material, labor, engineering, contracting expense, interest on capital invested and risk of accident incurred.

An engineer who will co-operate with a contractor in an effort to secure the best work for the place, and who does not try to force the contractor to lose money by being unreasonable in his demands for impossible work, is the man who has a large practice and does not feel the necessity of complaining about commissioners not employing engineers.

Engineers as a class are supposed to be above reproach, and to live in an atmosphere "where moth and rust do not corrupt, and where thieves do not break through and steal," while, on the contrary, county commissioners, councilmen and members of bridge committees are supposed to be more or less susceptible to "influence."

Inspector Byrnes will tell us that one educated rascal is more to be feared than a mob of uneducated ones, and it is a sad fact to relate, but nevertheless a true one, that the great numbers of "moth-eaten" and "rust-scarred" bridges which are now standing around the country are more to be credited to the work of certain educated rascals, who style themselves "engineers," than to the companies which built them.

It is reported that a certain firm of well known engineers built a railroad girder, not far from Joliet, Ill., and when the first locomotive passed over, the bridge "buckled," and was ruined. Another case of misplaced confidence took place not far from Jackson Park, when a Howe truss swing bridge, built and designed under the direct supervision of a firm of engineers, was condemned immediately upon its completion.

There is not a bridge manufacturer in the country who would build a bridge, if left to his own design and construction, which would not stand at least 20 years. Yet it is a fact that our best companies are often forced to build an inferior bridge under the direction of some engineer who has detail plans on file, and which when built will not stand the ordinary usage of the travel required for more than five years. To prove this fact, I can point out more than 1,000 ft. of such work, built under an engineer's supervision, and built strictly in accordance with such engineer's original design, which is now condemned, and will be replaced at once.

It sometimes happens that when bids are called for on certain work, a first class set of plans will be found on file together with proper specifications. These are usually furnished by some incog. bridge builder, through the mediumship of the local engineer employed on the work, or are even prepared by the bridge builder, at the direct request of the board in charge of the letting.

In rare cases, some engineers have been known to furnish as good plans as could be furnished by bridge builders. On about $200,000 worth of work, designed by engineers outside of any bridge company, and built within the last five years, I can show where the plans have been changed so as to cheapen the cost of the work from 10 to 40%. This, perhaps, was through no fault of the engineer who inspected and accepted the work, although I have no record of the contract or receiving less than the original contract price, though giving much less material than the engineer was under obligation to require him to furnish.

Business men look upon "reformers" as "cranks," and everybody knows that a "crank" should be locked up as a lunatic. The few successful bridge engineers are not the men whose great effort has been to secure cheap work and to keep the bridge builders from mak-

ing a fair profit on the work under their charge, but, on the contrary, the successful few are the engineers who help a contractor to secure a fair price for his work, and then insist that the work be done "on honor." There are few contractors who will not help an engineer secure a good piece of work if they can only get a fair price to repay them for their trouble.

A favorite hobby of the reformers is pools. Pools never harmed an engineer, but on the contrary, I know of one reputable and successful engineer, who drew a salary of $5,000 per annum, for several years, and every cent of it was paid out of pools.

Respectfully,

"Highwayman."

Cleveland, O., March 25, 1893.

NOTES AND QUERIES.

S. D. K., asks for a timber preserving process in which coal tar is used.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 249.)

Berlin, Ont.

So far as can be learned, the only sewage purification plant yet built in Canada, aside from a few for private institutions, is located at Berlin, Ont. This plant consists of a sewage farm which will first be systematically operated in 1893. Mr. Willis Chipman, M. Am. Soc. C. E., of Toronto, Ont., designed the sewage farm, and Mr. H. J. Bowman, Town Engineer, was in charge of construction. We are indebted to Mr. Chipman for the material from which this article has been prepared, and also to Mr. Bowman for the information mentioned below.

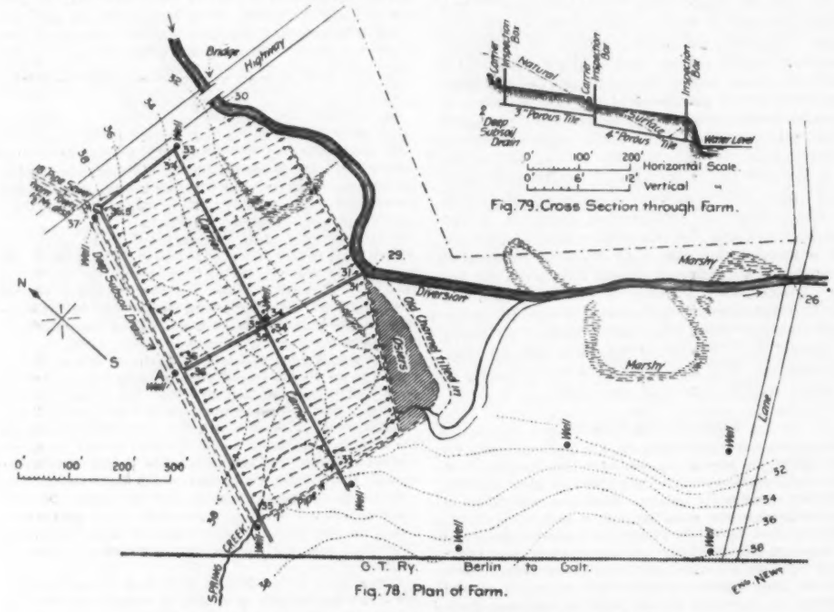


Fig. 78. Plan of Farm.

Fig. 79. Cross Section through Farm.

PLAN AND SECTION OF SEWAGE FARM AT BERLIN, ONT.

Berlin is the county town of Waterloo County, and is located two miles north of the town of Waterloo, with which it is connected by a street railway. The population of Berlin, by the Canadian census of 1891, was 7,425 and of Waterloo, 2,941. There are a number of manufactories in Berlin, including a large tannery and a glue factory.

Water-works were built by a company in 1888. The construction of sewers was begun in 1892, and is still in progress. To March 1, 1893, about 6,000 ft. of 12 and 9-in. sewers had been built, as also the outfall sewer, which is about 10,000 ft. long and 18 and 15 ins. in diameter. In March the quantity of sewage was about 50,000 gallons per day; diluted by some 75,000 gallons of subsoil water. In January, 1893, the temperature of the sewage at the farm was about 48° F.

The grading of the farm was completed late in 1892. During the winter, sewage has been applied to the farm, but not systematically. The sewage has a very dark color, and when stagnant for a short time gives off a highly offensive odor.

The farm is located about 1½ miles south of the town hall and a mile south of the closely built-up section of the town. A stream with a summer flow estimated at 200 cu. ft. per minute passes through the farm and receives the effluent, as shown by the plan, Fig. 78. One branch of this stream is the natural drainage channel of the town, and from the other a part of the public water supply is pumped. About two miles below the farm the main stream is ponded so as to back water for about a half-mile. Between the pond and the farm the stream has a rapid, unobstructed flow. There are farmhouses near the sewer farm, the nearest one being about 100 yds. from the end of the outfall sewer.

The farm bought by the town has an area of about 20 acres, nearly an acre of which is included in the bed of the stream. The total area purchased, aside from that occupied by the brook, can be used for sewer farming by grading, as the greatest elevation of the tract is only 3 ft. above the end of the outfall sewer.

Most of the surface soil is loamy or sandy, with a subsoil of gravelly clay. In places pockets of sand and gravel were found in a tough clay soil, and in other places there were shallow deposits of vegetable mold. The treatment of these irregularities in the soil is not stated in the information at hand.

About eight acres of the farm have been graded and underdrained, as shown in Fig. 78. The underdrains are of 3 and 4-in. tiles, with open joints, in lines 16⅔ ft. apart.

A section across the farm, parallel to the drains, is shown by Fig. 79. Inspection boxes, 6 ins. square, made of plank and covered, are provided at each end and the middle of the underdrains. Wells have been dug, as shown in plan, by Fig. 78, to facilitate observations of the height of the subsoil water. The trenches in which the underdrains are laid were backfilled for about a half of their lower portion with gravel from a pit about a half-mile distant.

It will be seen by referring to Fig. 78, that a stream which formerly entered the west corner of the farm has been diverted to a 7-in. pipe, and that the brook below the point where the effluent is discharged has been straightened. The plan and the section, Fig. 79, also show that a deep subsoil drain, ending in the 7-in. pipe just described, has been built along the west border of the farm. This was laid to divert as much subsoil water from the farm as possible.

The location of the two main sewage carriers is shown by the plan, Fig. 78. The upper carrier from the sewer outlet to the point A is made of an 18-in. split pipe, bedded in sand and gravel. The other carriers are simply ditches. A channel has been built across the farm to the brook to permit the discharge of sewage directly into the brook, if desired.

Mr. Chipman has recommended that Italian rye grass be raised on the two north divisions of the farm, and on the remainder mangolds and the other root crops, onions, oats and clover. On the low land bordering the stream osiers are proposed, they being raised for profit in Brantford, Ont., where dependence is had upon the freshets of the Grand River for irrigation.

Mr. Chipman states that the farm is suitably arranged for every known system of irrigation and every variety of crops, and that if properly operated he believes it could be made to pay running expenses, not including interest on its cost. He also states that it is quite probable that two of the four divisions of the farm will be converted into level areas this season.

No settling tank has been provided at the farm, preference being given to the application of solid matter directly to the land, where it can be dug in, or from which it may be raked off, as is found most desirable.

When the amount of sewage exceeds the capacity of the farm filter beds can be constructed at its south end with gravel from the pit already mentioned as being located a half mile from the farm.

Mr. H. J. Bowman, Town Engineer, informs us that $2,000 was paid by the town for the sewage farm of 20 acres, and that the cost of grading and underdraining the portion now ready for use was about $3,000. These items of cost are paid from an issue of sewer bonds bearing 5% interest, but the bonds sold at a premium, which practically makes the rate of interest 4½%.

CAN THE SO-CALLED "UNDERFLOW" OF THE SEMI-ARID REGION BE UTILIZED FOR GENERAL IRRIGATION?

By W. W. Follett.*

There is throughout the semi-arid plains of eastern Colorado and western Nebraska and Kansas a widespread and growing desire to utilize, if possible, the underground waters of that section for general irrigation, and a strong belief, fostered by the hope of success, that there is a sufficient hidden water supply to irrigate the whole of the territory in question. This belief is not shared by the few who have carefully studied the problem, approaching it without prejudice and seeking only its correct solution.

The popular idea of the underflow, succinctly stated, is about as follows: A large portion of the great plains is underlaid by a stratum of water bearing sand and gravel continuous with the beds of the main rivers and fed by the water from the mountain drainage which comes down these streams. This water bearing stratum is of great thickness, its water is moving freely through it and is practically inexhaustible and, if it can be brought to the surface, will irrigate a large portion of the country overlying it.

This belief is not formulated in words by the apostles of the underflow. In fact, when any one of them reads the above definition, he will take exception to several of its statements, feeling that he is not prepared to prove them; but several months' investigation and conversations with many hundreds of the residents of the region in question lead me to believe that this statement is a fairly correct expression of the popular opinion with regard to the underflow, and this popular opinion is the one we must meet and either accept or prove incorrect.

In and near the mountains many streams have a bed which was originally a rocky canyon, but has filled up with boulders and coarse gravel. In this debris often a large portion or all of the stream's low water flow sinks from sight to reappear only when some rocky reef crosses the channel and forces the water to the surface. The movement of the water through this gravel, owing to its porosity and the deep declivity of the stream, is often quite rapid and a considerable body may thus pass down the channel out of sight. This fact is often quoted and the assumption made that the plains must present on a much larger scale what here occurs, but without any recognition of the different conditions which exist in the two cases. Study of the underflow of mountain streams can teach us nothing whatever about the underflow of the plains. Reference to it is here made only to point out this dissimilarity and so to eliminate the mountain streams from the problem.

The condition to be discussed in this paper is: A stratum of sand and fine gravel of varying thickness and of small declivity, with its interstices filled with water, sometimes under pressure but generally, especially when near a cropping at the bed of a stream.

*A paper read before the Denver Society of Civil Engineers, March 28, 1893.

non-artesian in character. The problem to solve is: Given this condition, can water be obtained in sufficient volume and at such a cost that it can be utilized for general irrigation? A considerable amount of work has already been done in developing this hidden supply and, based on the meager results obtained, most roseate prognostications have been made by enthusiasts as to the possible development of the underflow.

It is the purpose of this paper to present, in as brief a form as possible, the few known facts relating to this underground water and its motion, or want of motion, and to formulate from them, if possible, some guess as to whether or not general irrigation from it is possible.

The physical condition of the area in question is about as follows: Stretching eastward from the foot of the Rocky Mts. is a wide plain, broken up and invaded on the west by the eroded channels of the mountain streams and the divides between them, but gradually becoming of more and more uniform surface, toward the east. For the purpose of this paper, we can consider this plain as covering the eastern one-fourth of Colorado and the western half of Kansas and Nebraska. It really extends eastward to the Missouri, but, after passing the 101st or 100th meridian, its surface becomes more and more broken up by waterways and ridges, and its character changes and becomes too complex for a general description, while its increased rainfall eliminates from it irrigation as an absolute necessity.

Generally speaking, this territory is a "buffalo-grass" country, with a deep soil of clay with some sand in it, called "marl" by the geologists. South of the Arkansas is a range of sand hills, evidently blown out of the river and lying on top of the marl. North of the North Platte is another sand hills country and south of the South Platte in Colorado, still another, all probably originating in the same way. Along the small tributaries of the Republican south and southeast of the town of North Platte is a deposit of very fine sandy soil of great depth. I think its geological name is "loess." South of Great Bend, Kan., is also a sandy country, apparently the "marl" with a large supply of sand.

Flowing from this country from west to east are several streams. These are of two classes. The two Plattes and the Arkansas form one class. They derive their main supply of water from the mountains and are subject, as are all mountain streams, to periodical floods and corresponding seasons of low water. During the late summer and fall of dry seasons, the South Platte and Arkansas both became perfectly dry east from the Colorado State line or near there.

The other class of streams consists of those whose source is on the plains and which have no mountain drainage. The Republican, and its tributaries, is the most important river in this class. Its storm water drainage extends into Colorado some 50 to 80 miles, but the first permanent water in the channels of its various branches is found near the state line. Within a few miles of where the first water is seen there is found a good, strong perennial stream varying but little in volume with the different seasons. For instance, the Frenchman, the most northerly headwaters fork of the Republican, is simply a dry stormwater channel until it crosses the line into Nebraska. About three miles east of the line the channel widens out into a meadow with numerous springs around its margin and three or four miles further east the Frenchman has a constant flow of 30 or 40 cu. ft. per second. Other streams belonging to this class are the three Loups north of the Platte and the Solomon and Smoky Hill in Kansas. These are all fed by the "underflow." Their significance, as showing movement of this underflow, will be considered later.

Underlying nearly the whole of this area is a water-bearing stratum of sand and fine gravel of varying thickness, and often broken up by intervening layers of clay or cemented gravel into several strata. This water-bearing material is composed of fine sand in its upper part, gradually changing to coarse sand lower down and grading finally into fine gravel. Taken as a whole, probably 30% of its bulk is voids which are filled with water. Its average thickness is hard to compute as very few wells go through it. At Hastings, Neb., a deep bore found the thickness of the water-bearing material to be 120 ft. In a well north of Lexington, Neb., it was found to be 17 ft. thick. In a few sections no sand at all is struck, water seeping in in small quantity, if at all, through cracks and small round holes in the clay, marl or magnesia rock. It is probably safe to say that the average thickness of sand is 20 or 25 ft., making 6 to 7½ ft. of water.

In the sand hills before mentioned, the local rainfall sinks into the sand, is arrested by the underlying marl and comes to the surface, or near it, wherever the sand is wanting or is thin. This water has, of course, no connection with the "underflow," and must be left out of the problem.

The soil of this region is, generally, a strong clay marl containing sand in a larger or smaller proportion and a good percentage of lime. It is rich in plant food, so deep as to be practically inexhaustible and needs only the magic touch of water to produce bountiful crops. The loess along the Republican gives fair crops on a rainfall that is not sufficient to raise anything on the adjacent marl. The same is true of the sandy country south of Great Bend, Kan., and, in fact, of any place where sandy soil is found.

The rainfall of this area varies in different parts, and in different years in the same part. It is not so important to know what the exact amount is as to know that, taking one year with another, it is not sufficient for successful agriculture. While last year, I am told, good crops of grain were raised in eastern Colorado, perhaps next year none whatever will be raised. The sandy soil spoken of as south of Great Bend, Kan., and North Platte, Neb., produces fair crops every year. Sandy soil here, as everywhere else, holds moisture and stands drouth much better than heavy clay or marl. Unfortunately, however, the sandy soils form but a small percentage of the whole acreage of this section.

The question of utilizing this underflow for general irrigation has been studied in a desultory way for several years. Unfortunately, the investigators have all been either real estate boomers or enthusiasts, and have generally reached conclusions first and then looked for facts to substantiate their conclusions, ignoring all others.

Two years ago last fall I was employed as assistant engineer for the artesian and underflow investigation of the U. S. Department of Agriculture, of which Col. E. S. Nettleton was chief engineer. Under instructions from Colonel Nettleton, I was detailed to collect facts bearing on this problem of the possibilities of general irrigation from the underground waters. Altogether, about six months were spent in the work, nearly 900 miles of stadia line were run, getting elevations by vertical angles and about 265 wells examined. The well examination comprised the getting of as complete a log as possible of the strata passed through, the quality and quantity of water obtained, and, from the vertical angle and stadia work, the elevation of ground, water surface and bottom of well. This information was platted upon profiles, showing the relative elevation of the streams crossed and of the water in each well.*

Several lines were run which were rather negative in results, as being outside the underflow country. Such were the Cheyenne line, the Loup line and the Sterling line. Five were run across the drainage of the Platte, crossing the South Platte at Sterling, Colo., and Big Spring, Neb., and the main Platte at North Platte, Lexington and Grand Island, Neb. The Sterling line was too far west to show anything of value. A line was also run east from Sterling into the head of the Frenchman drainage and then down that stream to the point about three miles east of the state line, where water first begins to flow in the stream. It connects with the south end of the Big Spring line. On the Arkansas three lines were run, crossing the river at Great Bend, Dodge City and Garden City, Kan.

A study of these lines will show that the sheet water south of North Platte and of Lexington may be fed by the Platte, and south of Garden City and Dodge City by the Arkansas. The other lines all show that the source of supply cannot be the mountain streams.

The Frenchman line was run especially to find, if possible, the source of the water which flows in the lower part of this stream. In and around Venango, Neb., a small town two miles east of the Colorado line on a branch of the Burlington R. R., and around Holyoke, Colo., I found a general belief that the sheet water under them came directly from the South Platte. At Sterling, Colo., the river flows northeast, this being its general course for about 30 miles above Sterling. I started a line directly east from Sterling. For the first eight miles after leaving the river the country rose rapidly, reaching an elevation above the Platte of nearly 600 ft. Then a prairie country was entered, sloping gradually to the east and forming part of the Frenchman drainage. Fourteen miles east of the divide was the first well I struck, which went down to the "sheet water." It was 100 ft. deep and its bottom was over 100 ft. above the South Platte at Sterling. Wells east of this point show the easterly fall of the water-bearing stratum to be at first about 18 ft. to the mile, gradually flattening to about 10 ft. per mile. It being 22 miles west from this first sheet water well to Sterling, a gradient of 18 ft. to the mile would throw this water-bearing stratum about 500 ft. above the South Platte. As the Platte here falls but 8 ft. per mile it is easily seen that, even if the slope of this water sand were materially flattened to the west—a totally untenable proposition—there is no likelihood of river and sand stratum coming together.

Going east from this well, the water bearing sand was traced continuously until ground surface and the sheet water came together three miles east of the state line, in the meadow before mentioned. This meadow is about 120 ft. higher than the South Platte, at Big Spring, Neb., about 35 miles due north of it, so that it seems absolutely impossible for any of its water to come from the Platte.

Going north from Garden City, Kan., the sheet water is found to rise to the north, away from the Arkansas, at the rate of between 2 and 3 ft. per mile. As the general course of the river for a long distance west is about due east, it is impossible for this water to come from it. South of Garden City the same slope is found following away from the river, so that, so far as this particular section is concerned, the sheet water may be fed by the river, although the latter may receive as much from the north as it gives to the south.

These two cases are cited as showing most plainly the source of the water supply. Many other facts were gathered, all tending to confirmation of the assumption that the sheet water, broadly speaking, receives none of its supply directly from the mountains. This is important, as tending to assist in computing the possible supply. Its source must be the western portion of the great plains with very little, if any, foothill drainage. Here the rainfall is light, and the soil in general not such as will freely imbibe water, and the evaporation is rapid. All these conditions tend to show that the supply of underground water must be limited.

The next step will be to determine, if possible, the rate of movement of water in sand. Here we have no definite information on which to work. If exact data existed for certain given conditions it would be almost impossible to apply them to other cases, as at least three variables enter into the problem; the quality of the sand, the slope of the water-bearing stratum, and whether or not the water is under pressure; the same combination of these variables is not likely to occur twice. Some English engineers determined by experiment that water moved through sand at the rate of one mile per year, or ¼ in. per minute. Mr. Donald W. Campbell reports that he made some rough experiments in the Gila River sand, in Arizona, and thought he detected a movement of ¼ in. per minute. I tried in Cherry Creek sand, very coarse, and in a channel having about 25 ft. per mile of fall. I could detect no movement, but my method of work was crude.

Three miles north of Garden City, Kan., on a low plateau, which had been irrigated for two or three years, I found on Dec. 21 or 22, 1891, a well in which the water had risen 10 ft. since irrigation had commenced, and, although irrigation had stopped for the season some six weeks before I was there, the water in the well had not receded any. The water in all the wells in this irrigated section had risen in the same manner, although not to so great a height in all as in this one. Now, if the water in the sand and gravel at the bottom of these wells was moving at anything like the velocity claimed by some, or even at one-tenth that velocity, it seems to me that it would have completely carried away any surplus water above it in much less than six weeks. During the irrigating season of 1890 the water in the well mentioned rose above its former height some 5 or 6 ft., and remained at that level all winter. This seems to be a very significant phenomenon in its bearing on the probable movement of water in sand.

There are data enough in existence relating to the Frenchman and its drainage to enable one to form a rough guess at the movement of water in sand and the rainfall necessary to supply the underground water. The known conditions are: A drainage area in Colorado of about 600 square miles, a width of drainage area at the state line of 15 to 18 miles, and a flow in the Frenchman of 30 to 40 cu. ft. per sec. Now, assume that the channel of the Frenchman draws, say, 60% of the water which crosses the state line for four miles north and two miles south of it; then about 60 cu. ft. per sec. would have to cross the state line in the six miles. If the average depth of this water-bearing sand be assumed as 25 ft., and it is about this, the cross-section will be:

$$5{,}280 \times 6 \times 25 = 792{,}000 \text{ sq. ft.}$$

Assuming that the water occupies one-third of the area, the water cross-section will be 264,000 sq. ft. The flow is 3,600 cu. ft. per min., or, the current must be 1-6 in. per min. This compares favorably with the results of the English engineers and of Mr. Campbell, being about a mean between the two.

It is likely that the current in the remaining nine or twelve miles of cross-section is considerably less than along the Frenchman, where the declivity is greater and, especially near the cropping, the finer sands washed out, giving the water much freer movement in the sand. Assume that the rest of the cross-section passes the same amount of water as the six miles near the stream; then 120 cu. ft. in all will cross the state line each second of time. Of the drainage area of 600 square miles, assume that only two-thirds can contribute to the underflow. Then this 120 cu. ft. per sec., or 3,784,320,000 cu. ft. per annum, must be furnished by the rainfall on 400 square miles of territory.

A little over 4 ins. of water each year over the 400 square miles must therefore go into the ground to

*A great deal of information is contained in these profiles and in the tabulated statements of wells examined. Any one curious to examine them can get a copy of the report by writing to his congressman for Ex. Doc. 41, 52d Congress, 1st Session, Part 2. There are four parts to the report, Part 1 being a review of irrigation progress and prospects in this country; Part 2 the chief engineer's report; Part 3 a geological report, and Part 4 a report of two special agents. The report is now, I understand, out of print, but Congress, at its last session, ordered another edition of 10,000 copies, so that it will soon be again obtainable.

supply this 120 cu. ft. per second. When we remember that the annual rainfall of this section is light, perhaps 12 to 15 ins. per annum, and at least one-third of this comes in very heavy rains, when a large percentage of the rainfall quickly runs off, it is seen at once that the assumption that 25 to 35% of the annual precipitation goes to subterranean water supply, is likely to be a nearer approximation to the truth, or, if in error, to be too large a percentage.

About one mile north of Garden City is a well 13 ft. deep and 8 ft. in diameter, with 3 ft. of water in it on an average. From this well is pumped a maximum of 80 gallons per minute; but this rate of pumping will lower the water. Assuming that the whole circumference of the well will furnish water uniformly for 3 ft. in depth, this draught of 80 gallons per minute will require a current of supply of about 5 ins. per min. through the gravel, assuming, as before, that the water occupies one-third of the total space. This shows that the current can be accelerated; but for how long this supply would be kept up, or how near together such wells can be put, we do not know. In many other cases of wells having apparently as good a supply as this one, a draught of one-third to one-tenth as much water will quickly lower it below the buckets of the pump.

Considerable misunderstanding exists among the people living on the plains as to what constitutes a supply of water adequate for general irrigation. They judge of the relative volume of water different wells will furnish by the amount of stock which they will water, or from the amount which can be pumped from them. When a well is found which will water 200 or 300 head of stock, or from which a 10-ft. windmill on a good pump cannot pump water enough to lower its level in the well, the supply is spoken of as "inexhaustible." For instance, at Kit Carson, Colo., is a well from which has been pumped by steam 2,900 gallons per hour, and it is cited far and wide as furnishing evidence of the immense quantity of water which can be obtained from the underflow for irrigation. As this well furnishes 1-10 cu. ft. per sec. and would irrigate only 15 or 20 acres of ground, the evidence furnished is not so wonderfully startling after all. Many similar instances could be cited, showing that these people lack an appreciation of the amount of water needed for practical irrigation on a large scale.

Such are the conditions as they appear from the limited facts known to me. The conclusion reached, is that the underground supply is not large enough to make it a safe financial investment to expend large sums for costly plants to bring this water to the surface for irrigation. Right here I am met, or may be met, with the statement that this has been done in several localities. There is a ditch, or was two years ago, in an incomplete condition near Ogallala, Neb., for utilizing the underflow of the Platte. I have never heard of its completion and successful operation.

There are also two or three underflow ditches on the Arkansas, one, at least, of which is in use. This is a few miles above Dodge City, Kan., on the south side of the river. Here an excavation two miles long and about 10 ft. deep has been made with its bottom 6 ft. below the average water level in the sand. The grade of the river valley is here about 8 ft. per mile, and the grade of the ditch leading from the lower end of this cut is about two feet per mile, so that it is practically two miles from the lower end of the cut to the point where the water is brought up on top of the sandy bottom lands. In the two miles of deep cut has been obtained a water supply of about 30 cu. ft. per sec., or a little less. Figuring the cost of moving this sand at 15 cts. per cu. yd., and it will be fully this, as at least 40% has to be moved in water; and supposing the bottom width of cut to be 10 ft., with slopes of 2 to 1, the two miles of cut with its two miles of tail ditch must have cost between $25,000 and $30,000. In other words, it has cost about $1,000 per cu. ft. to deliver the water to the head of the irrigation canal. I was told two years ago at Dodge City that about one-half of the water obtained at the head was lost by seepage before the ditch reached sufficient elevation to cover any lands fit for irrigation. This open cut is very likely to be partially filled each year by the drifting sands of the river valley, so that each spring must be met a large expense for cleaning out. The other cases cited of existing subflow canals do not offer even as favorable results as does this one, so I will not discuss them. I am afraid, however, that if any one of us advocated a scheme for general irrigation, outside of the growing of citrus fruits or raisins, in which the expense of headworks alone was $1,000 per cu. ft. of water delivered into the head of the canal, we would be considered fit candidates for the insane asylum, especially if our headworks were only of temporary construction, and the upper end of our ditch were so badly located as to lose half its water from seepage before reaching the irrigable land.

In the light of the facts and the inferences formulated in this paper, it seems safe to assume that the following conclusions are fairly well established.

(1) The underflow is not supplied from the snow or rainfall of the mountains.

(2) Its rate of movement in the sand is very slow, hence:

(3) The amount which may be drawn from it without permanently lowering its level is small.

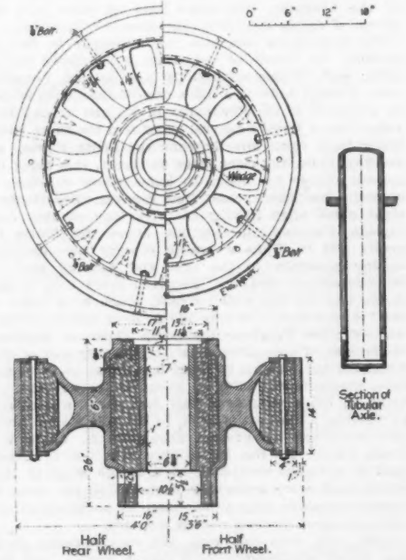
(4) Each farmer on the great plains whose land is underlaid by this sheet water at a moderate depth can hope to obtain by pumping water enough to irrigate a small garden and truck patch, say, two to five acres, but:

(5) The supply is not such as to warrant large expenditures in constructing plants intended to obtain water sufficient for general irrigation. Even if momentarily successful, as a plant would be drawing down the surface of a lake with no outlet, the supply will be exhausted. In other words, the water surface will be permanently lowered, and disaster to the irrigation plant will follow.

These conclusions are reached not only from a consideration of the facts here stated, but also by weighing many other known conditions, a full statement of which would many times increase the length of this paper.

HEAVY WAGON CONSTRUCTION.

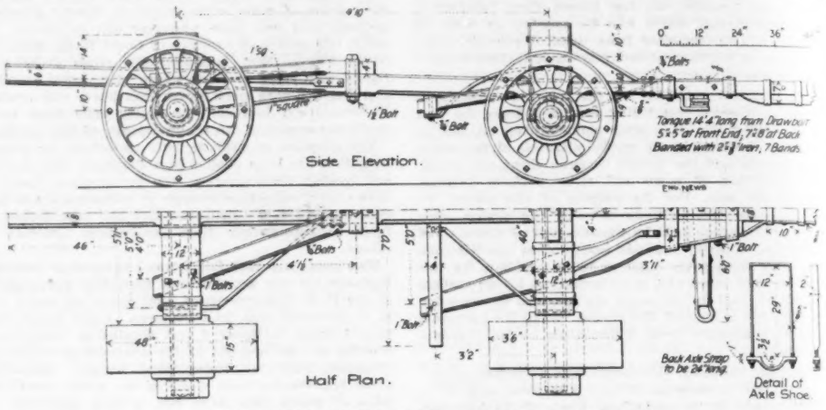
The wagon here illustrated is made and used by the Mueller Coal, Heavy Hauling & Transfer Co., of St. Louis, Mo., chiefly in handling the heavy reels of street railway cable required for use in that city. Mr. Henry Mueller, the president of the company, writes that the broad wooden wheels formerly used with this wagon failed utterly after six months' service by the spokes crushing into the hub under the heavy load.



Wheel of Truck for Heavy Loads.

To meet this emergency Mr. R. C. Pope, manufacturer of the Pope road roller, designed the compound wheel here shown. As plainly illustrated in the cuts this wheel has a hub and felloes of wood; but the spokes are replaced by a framework of soft steel, so arranged as to prevent any loosening between the hub and felloes, and yet retain the more elastic wood as a cushion to take up shocks.

This wagon has hauled a load of 95,115 lbs. of cable across the city of St. Louis, and Mr. Mueller considers it safe for any load under 75 tons, or 18¾ tons per wheel. After a year's use the wheels show no signs of a failure, and are "as per-



TRUCK FOR HEAVY LOADS; 75-TONS CAPACITY.

fect as on the first day's trial," says Mr. Mueller. The weight of the wagon is about 10,000 lbs., and the cuts plainly show its design and general dimensions.

ELECTRICAL COAL MINING.

The adaptability of electric power for various purposes in connection with mining operations is now a well accepted fact, and although its application for such purposes is already quite extensive, it is probably only the beginning of a very much more extended use. As shown by various articles in our columns, it is employed for hauling cars in and around coal mines, and for lighting, pumping, coal cutting, drilling, etc. An article on the use of electricity in bituminous coal mining was published in our issue of July 21, 1892, and one on the electric percussion drill in our issue of Aug. 25, 1892. We publish this week an interesting paper on coal mining, or coal cutting, by electricity, by Mr. James T. Burchell, manager of the Gardner Coal Co., of Sydney, C. B., Nova Scotia, which was presented at the International Convention at Montreal in February, 1893, a report of which was given in our issue of March 2.

From the rapid increase in the number of coal mining machines used, the increasing quantity of coal produced by machinery, and the fact that in many collieries where machine mining has been tried the number of machines is being increased, I think that we can take the ground that the practicability of cutting coal by machinery is an established fact. Any one familiar with the reclaiming of coal by this means will readily concede that it has many advantages over coal cutting by manual labor. First, and most important, is economy of production; second, saving of coal, or rather greater proportion of large coal and less slack or culm; third, less powder required to blow down the coal, as the undercut is so much deeper; all mining men will readily understand the advantage this is to the coal; fourth, less pit-room required for same output, consequently less number of tracks to be laid; fifth, much less danger to workmen, as a large percentage of accidents occur to miners while undercutting. The fact seems then established that the coal mining of the future has to be done largely by machinery if we are to compete successfully in the production of coal, and it is important to consider the machine that is most suitable for the work required and the most economical way to transmit power to drive it.

In considering the first point, I would say that many different kinds of coal-cutting machines are now being successfully used, all of which have their advocates, but the types of machine that so far have done the most successful work are those of the reciprocating pattern, such as the Youch, Harrison, Ingersoll-Sargent and the Sperry, and the rotary or revolving pattern as represented by the Jeffrey, Leichener, Thompson, Van Depoele, Schlesinger and Edison machines. These of the first-named pattern attack the coal by a blow as with the pick, and as they are under the complete control of the operator, can be guided so as to perform the work in coal where they might come in contact with iron or sulphur balls that it would be im-

possible for the rotary machine to work through. They have the advantage of being much lighter, some of them weighing only about 500 lbs., consequently easier to move from room to room, and the cost of the machine is less than those of the other pattern.

The working of these machines is harder on the operator and requires more skill in handling than those of the rotary pattern. The rotary or revolving machine will do better work and more of it, with less labor for the operator, when the circumstances are favorable for its successful working. Where the seam is narrow it requires an even floor; must have the coal clear of impurities of a hard nature, and requires a good roof. In fact, all mining machines require this latter, as timbering close up to the face of the work would be very much in the way of the machine. The rotary machine being of greater length than the others would require a stronger roof, the lighter machine having a better chance to work around the timber.

Neither of these types of machines can be expected to give satisfactory results in all mines or all classes of coal, and if this fact were better understood there would be less prejudice against coal-cutting machines and a more intelligent investigation into the question of adaptability of the machines to do the work required, which I am confident would lead to a much more rapid increase in the use of coal-cutting machinery.

In Cape Breton the Ingersoll-Sargent is worked successfully in the Emery Colliery of the Sydney & Louisburg Coal & Railway Co., in the Gowrie Colliery of Archibald & Co., and in the Caledonia Colliery, where I am told the plant is to be increased. The machine I am most familiar with is the Jeffrey electric coal-cutting machine. This machine consists of a bed frame 2 ft. wide by 8½ ft. long, composed of two steel channel bars firmly braced, the top plates on each forming racks with teeth downward, with which the feed wheels of the sliding frame engage. Mounted upon this is the sliding frame, upon which is placed the electric motor from which power is transmitted through straight gear and worm wheel to the rack by means of which the sliding frame is fed forward. Upon the front end of the sliding frame the cutter bar is placed. The cutter bar contains steel bits held in place by set screws, and is driven by an endless chain. The machine is operated by two men. It is run up to the face of the work on a truck, unloaded and firmly jacked against the face of the coal, and the roof in rear of the machine. The power is then turned on by the man in charge of the machine, and it proceeds to work. The cutter bar being revolved by the endless chain, is fed forward to a distance of 5 ft., making a cut of that depth 3 ft. 3 ins. wide and 4 ins. high. When the cut is completed the lever is reversed and the cutter bar withdrawn, the jacks are slackened down and the machine is moved broadside across the width of the cut, placing it in position for the next cut. When the room is cut across, the machine is loaded on the truck and removed to the next room.

When we come to consider the second point, the most economical power to use, I know I am treading on dangerous ground. The question of electricity versus compressed air has been a battle-ground for the past few years.

One of the strongest papers that I have noticed in favor of compressed air as against electricity is by David J. Lloyd, Manager of the Edinburgh Coal Co., published in the "Colliery Engineer" of December last, in which he shows a loss of 68% of power from the generator to the motor, or only an efficiency of 32% of the power conducted by electricity, also a loss of 40% from the engine as developed by the generator, making in all a loss of 81%, or only 19% efficiency of power of engine produced at motor. While his compressed air plant shows a loss of only 34% from steam to air, and a loss of 7.4% from the compressor to the mining machine, I do not think that this is a fair comparison, as Mr. Lloyd admits that the electric mining machine that he tried was a failure and never made a single complete cut. Mr. Lloyd figures the loss of 68% from generator to the cutting machine, because his generator was developing 23.5 HP. and his motor on machine was rated only 7½ HP. He admits that there was no loss on the wires, so that the full current of 23.5 HP. was delivered at the machine. Now it is quite clear that if the current was delivered at the machine, his motor, although only at 7½ HP., must for the short time it worked, have developed 23.5 HP., less loss of the efficiency of the machine; but as Mr. Lloyd does not take this loss into account in estimating the power of his air machine it need not be considered, so that we can at once strike off the 68% loss. The loss he shows from the generator and engine, 40%, although only 6% higher than he shows from the engine and compressor, is at least 10% greater than is usually found in well designed steam and electric plants of similar size. This, I think, can be accounted for in his case by the use of an engine of at least double the size required to do his work, which would double the percentage of frictional loss of the engine, as steam engines are usually found to show about the same loss by friction irrespective of load.

Applying to one of the largest manufacturers of compressed air and electric mining plant in the United States for a comparison, I secured the following reply: "We consider electric power the strongest, steadiest, most economical and the simplest to handle. The loss in transmission of power from power house to mines is less with electricity than with the air. The liability of leaks in pipes, also friction, is greater with air, so much so that in mines where we have the air power in use we have a loss some days as high as from 50 to 60%, while at other mines, the same distance with electricity, the loss is less than 30%."

In my own experience, I have not found nearly as much loss I have tested the current day after day when the machine with motor was 800 ft. from generator, and found the loss not to exceed 5%. This loss can be almost completely overcome by increasing the size of the conductor, so that resistance will be lessened in the transmission, and by proper insulation. Many of the mines in the United States are wired with bare wire without any insulation.

The Chief Inspector of Mines of the state of Ohio, accompanied by three expert electricians, visited eleven collieries where electric machines were in use, opened the circuit at each machine and inserted an ampere and voltmeter, and recorded the reading every 15 seconds throughout the cut. His statement shows the horse-power required to overcome the frictional load to be between five and six, and only 6 HP. is required to cut a square foot of coal in a minute in some cases, while in others it requires 14 HP. This great difference is due to the fact that the coal is much harder in some mines than others, and also to the cutting bits becoming dull—the test being made under all these different circumstances.

I have often seen a cut made in four minutes with sharp bits, when in the same coal if the bits were allowed to get dull it would take ten minutes. An excellent paper on this subject, by Mr. D. S. Bigge, was read before the North of England Institute of Mining and Mechanical Engineers, at Newcastle, on Feb. 13, 1892, an abstract of which paper appeared in the "Colliery Engineer," of April last, in which he speaks very strongly in favor of electrical power. This paper I would advise every one interested in this subject to read.

The phenomenal advancement of the introduction of electricity as a motive power should lead any one intending to install a mining plant to carefully consider its many advantages, and although its advocates have met with many discouragements, it continues to make rapid advancement, and I have no doubt that at no distant day it will become the leading form of the transmission of power. Among some of the advantages claimed for electricity is that the power can be carried longer distances with less loss than by any other means, and at less cost; the conductor requiring less space can more readily be put in position by less experienced workmen, and connections for branch circuits can be more easily made than on conductors of any other power. Electric power can be utilized for more kinds of work—I might mention coal cutting, hauling either by motors or electric hoists, pumping, running fans, and lighting.

Having undertaken to work a thinner seam of coal than had previously been successfully worked in Cape Breton, where so many large seams of coal exists, I found I was compelled to pay a higher rate for coal cutting than was paid at any of the other collieries. I commenced two years ago to inquire into the practicability of mining by machinery, and after careful examination of most of the machines worked in the United States, I purchased a Jeffrey coal cutting machine worked by electricity, and had Robb & Co., of Amherst, N. S., install an electric plant. The generator was 30 HP., placed about 80 ft. from the mouth of the shaft. We use No. 0 Okonite wire to conduct down the shaft, and the ordinary insulated wire from foot of shaft to where the machine worked, a distance of 700 ft. The motor attached to the machine was rated at 12 to 15 HP. I felt at the time that I was running quite a risk in attempting to run electric power, situated as we are, hundreds of miles from any one who knows the first thing about electricity; but the machine was put to work in September, 1891, and has worked constantly since, with the exception of the time the mine was idle in the winter months. The machine never missed one day's work when we had work for it to do. Any repairs that it required were done on the works, and always in time for the machine to do its day's work. It takes from four to six minutes to make a cut 5 ft. deep and 3 ft. 3 ins. wide. We have cut a room 25 ft. wide across in 55 minutes. It takes 30 minutes to move the machine from one room to another. But we have had the best results when we have worked the machine in long-wall works, where it has cut a face of 155 ft. by 5 ft. deep in eight hours. When we have worked the machine in long-wall works we have saved 30% in cost of cutting.

I make no claim for the superiority of this machine, but merely give my own experience. Other machines that I have not had any experience with may do as well, or better. Several have been patented within the past year that give promise of doing efficient work. A description of one called the Brown coal cutting machine, invented by Adam Kell, of McKeesport, Pa., appeared in the July issue of the "Western Electrician," and shows excellent points.

While leaving the choice of machine an open question, I do not think there can be a doubt in the mind of anyone who has had any experience with electricity that it is far ahead of any other power when the work is at a distance from the power-house. There may be some types of machines working successfully with compressed-air, to which as yet electrical power has not successfully been applied—but this does not disprove my contention.

I have found in the use of electricity that the most important objections raised against it are imaginary. There is no danger to workmen from contact with wires, as it would require a current at least three times as strong as is generally used for mining purposes to cause the slightest danger from contact with even the bare wire; and there cannot possibly be any more danger of exploding gas by the flash from the brushes than there is from a naked lamp. Therefore this argument cannot be raised against its introduction in Cape Breton, where naked lamps are used in all mines. Still, it must be admitted that in very gassy mines electricity, as at present used, would be attended with some danger. But the objection most often made use of is perhaps the most absurd one, namely, that it is a new power that we cannot understand. If we refuse to make use of any power that we do not understand I am afraid some of us would not do very much mining. I am not an electrician, and must confess that I know very little about electricity, except that its power can be carried safely and economically from the surface to the most remote parts of a mine, and then made to do efficient work.

LAKE SUPERIOR IRON ORE PRODUCTION.

In a late issue the "Iron Trade Review," of Cleveland, O., publishes a supplement giving the iron ore production for each mine in the Lake Superior region, with the total production prior to 1878, and annually to and including 1892. Space forbids the reproduction in full of these statistics, but we reprint the totals in tons for the several ore-producing ranges, for the years given, as follows:

	Prior to 1878.	1880.	1885.	1892.	Total production.
Marquette Range	10,422,249	1,384,010	1,480,422	2,666,856	37,917,591
Vermillion Range	.....	.....	225,484	1,167,650	5,285,173
Mesaba Range	.....	.....	.....	4,245	4,245
Menominee Range	4,503	524,735	690,435	2,261,460	16,779,261
Gogebic Range	.....	.....	119,860	2,973,993	13,260,296
Miscellaneous	.....	.....	.....	.....	2,320
Grand total					73,248,796

The first annual record of production for the Vermillion Range commences in 1884, with 62,124 tons; and in this same year, the Gogebic Range commenced with an output of 1,022 tons. The latest of all developed is the Mesaba, which was opened to the market last year.

A reservoir drawing-pen has been brought out by Jackson Bros., 50 Call-Lane, Leeds, England. It is an ordinary hinged-rib drawing-pen, provided with a hollow celluloid handle. In this handle is a removable cylinder, carrying the ink, with a small tube leading to the pen point, and a plunger in the cylinder by which the ink is driven down. The whole thing is a miniature hand-pump, the pen being filled by inserting the tube in the saucer and withdrawing the plunger. The cylinder is then wiped clean and put into the handle, with the plunger still out. In use, a slight push on the plunger feeds the ink to the pen as required. The ink will keep good in the cylinder for days, and the pen can always be used as an ordinary pen.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

OHIO & MISSISSIPPI.—The contract for extending the Cincinnati & Bedford Branch from a point at Mitchell Hollow to a connection with the Bedford Belt R. R. at Bedford, Ind., has been let to Morris, Serpell & Co., of Louisville, Ky. Work will begin at once.

BALTIMORE & OHIO.—The Union Exchange & Transfer Ry. Co. has been organized as a feeder to this company. The new road will start from Library, a small station in Allagheny Co., Pa., on the Wheeling division, about 12 miles from Pittsburg, where work will first be commenced, and will also strike Finleyville. From this point it will cut across the country

down to the Monongahela Valley and will parallel the P. V. & C. R. R. for a short distance, and at or near Monongahela City, follow the course of Pigeon Creek for a distance and then cut across the country to Charleroi, where a bridge will be built, cross the Monongahela River to the Bellevernon side, and thence by a devious route, connect with the main line of the Baltimore & Ohio at Layton station. From Layton it will connect with a new branch to be built by the P. R. R. at an as yet unknown point. At the Library end it will connect with a new branch to be built by the Wabash system.

TOLEDO & OHIO CENTRAL.—J. S. Casement & Co., of Painesville, O., have been awarded the contract for the extension of this line to Columbus, O. The work has just commenced and the headquarters of the contractors will be at Marysville, O. The extension begins at Ridgeway, O., to which point the road was extended in 1891, and it has been located through the towns of West Mansfield, Newton, Peoria and Marysville to Columbus, a distance of 60 miles.

Projects and Surveys.

CAPE BRETON.—It is stated that a syndicate has taken up the project of building a railway from Louisburg to Port Mulgrave, on the Strait of Canso, 70 miles.

MONROE & TOLEDO.—This company has been chartered in Michigan with a capital stock of $128,000. It is stated to be in the interest of the Flint & Pere Marquette R. R., who will extend to Toledo, O.

Southern.—Existing Roads.

WEST VIRGINIA CENTRAL & PITTSBURG.—The surveys are nearly completed for the extension from Cumberland to Hagerstown, Md., and it is stated that contracts will be let about May 1.

Projects and Surveys.

MOBILE, FLORENCE & TUSCALOOSA.—A meeting of parties interested in this proposed road will be held some time in April, when some movement will likely be placed on foot for the carrying out of the project. This is the road planned in accordance with the report of the State commission appointed to survey a railroad connecting the waters of the Tennessee River with those of Mobile Bay. Thomas Seay, of Greensboro, Ala., can be addressed.

Northwest.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—A movement is on foot to secure the construction of an extension from Ruthven, Ia., to Jackson, Minn.

JACKSONVILLE SOUTHEASTERN.—A bridge is to be built over the Illinois River at Columbiana, Ill., and an extension built along the east bank of the Mississippi River to East Louisiana, 28 miles. A charter for this bridge has been granted, and plans and specifications have been approved. Mr. E. L. Corthell, of Chicago, is consulting engineer.

CHICAGO & EASTERN ILLINOIS.—The contract for building the extension from Rossville to Sidell, Ill., 34 miles, has been awarded to McArthur Bros., of Chicago, who have sublet the work. H. F. Baldwin, Chicago, is Ch. Engr.

CHICAGO & EASTERN ILLINOIS.—Mr. A. F. McArthur, of McArthur Bros., of Chicago, informs us that they have been awarded the contract for constructing the extension of this road from Rossville to Sidell, 35 miles. This extension leaves the main line at Rossville, 15 miles from Danville, and runs southwesterly through Ross township; thence south to Sidell, connecting with the Tuscola & Shelbyville extension which was built by McArthur Bros. in 1891.

BURLINGTON & MISSOURI RIVER.—About 1,500 men are now at work on the 26-mile extension to Spearfish, S. Dak. The larger part of the work is heavy. Contrs., Kilpatrick Bros. & Collins, Lincoln, Neb.

Projects and Surveys.

CHICAGO, JOLIET & SOUTHWESTERN.—Chartered in Illinois to build a railway from Chicago to the Mississippi River at a point opposite Burlington, Ia. Among the incorporators are: J. E. Williams, Chas. Macklin, Geo. Wilson and others, of Chicago.

CHIPPEWA FALLS & NORTHERN.—This company has been organized to build a railway from either Chippewa Falls or Cadott, Wis., to River Falls, Wis., 40 miles. Ch. Engr., Sam. Crabbe, Eau Claire, Wis.

Southwest.—Existing Roads.

FT. WORTH & RIO GRANDE.—Rapid progress is being made on the survey of the line from Brownwood, Tex., south.

ST. LOUIS BRIDGE & TERMINAL CO.—This company has presented the plans and specifications for its new $500,000 passenger depot to the board of public improvements. The structure will occupy a solid block with its trainshed, and will be of the most modern design and thoroughly fireproof. The materials to be used in its construction are granite, iron and Bedford buff stone. Work will be commenced on the depot as soon as the board of public improvements accepts the plans and specifications.

Projects and Surveys.

RECLAMATION RY. CO.—This company has been chartered in Kansas City, Kan., with a capital stock of $1,000,000. The charter states its objects to be to reclaim submerged lands and construct railway tracks; to pledge the corporation for the improvement of the Missouri River for navigation; to pledge the corporation and contract for the erection of bridges; to do, perform and transact any and all acts pertaining to redeeming of lands and building of railways, telephone and telegraph lines, and operating the same in Wyandotte, Kansas, and Jackson and Clay counties, Mo.

Rocky Mountain and Pacific.—Existing Roads.

NEW MEXICO.—A railway company has been incorporated to build from Grant Co. iron mines, through Doña Ana, Lincoln, Chaves, San Miguel, Mora and Colfax counties.

BURLINGTON & MISSOURI RIVER.—A press dispatch states that a surveying party is now being fitted out to run a line from Sheridan, Wyo., to Great Falls, Mont. It is also stated that Kilpatrick Bros. & Collins are advertising for 1,000 men at Sheridan.

ELECTRIC RAILWAYS.

HAMILTON, ONT.—Chartered, Hamilton, Waterdown & Guelph Electric Ry.

FITCHBURG, MASS.—The board of aldermen has granted the Fitchburg & Leominster St. Ry. Co. the right to use the single trolley electric system in place of horses on all its tracks in this city. Work will be begun at once on making the change. A petition is before the board of aldermen from the same company for double-tracking about one-half mile of their road on Main St., which will probably be granted.

BROOKLYN, N. Y.—The Atlantic Avenue R. R. Co. has has made a contract with the Westinghouse Electric Co. for its supply of motors, which will be needed in the operation of its trolley cars and for its electric generators. The contract is a very large one. The contract price is $1,000,000. The number of motors that will be needed by this line is 400.

MONTCLAIR, N. J.—At the annual citizens' meeting on April 4 the township committee was requested to obtain definite proposals for a street railway franchise under certain stipulated conditions. Two applications for franchises were before the meeting, one from the Suburban Traction Co. and the other from the New Jersey Traction Co. Motions in favor of granting either of these applications were voted down in order to secure more definite proposals and invite wider competition. Montclair is a wealthy suburb of New York with a population of about 10,000. Any street railway built will eventually form an important link in the suburban system connecting Newark, Jersey City, Paterson, Passaic, Montclair, Bloomfield and the Oranges.

WILLIAMSPORT, MD.—The mayor and town council have submitted propositions to the New York capitalists, who propose building an electric street railway in Hagerstown, to extend the system to Williamsport, six miles distant. Williamsport agrees to invest $20,000 in the stock of the company, and give the free use of all its streets, besides the donation of a park along the Conococheague.

SCRANTON, PA.—Chartered, Scranton & Abington Street Ry. Co., Scranton to Abington; capital stock, $300,000; Pres., Chas. D. Brick.

CHILLICOTHE, O.—The Chillicothe Electric Ry. & Lighting Co., together with the Juneman electric light plant, has been sold to a New York syndicate for $140,000. The new company will expend $40,000 in laying new tracks, making a 2-mile extension, and putting new cars on the street railroad.

CLEVELAND, O.—The Cleveland Electric Ry. Co. has been chartered, consolidating the East Cleveland R. R. Co., and the Broadway & Newburg St. Ry. Co. Capital stock, $6,500,000.

MT. VERNON, O.—Chartered, Mt. Vernon Electric Ry. & Light Co.; capital stock, $400,000; operating electric railways, furnishing light, heat and power, etc.

MARION, IND.—The Marion City Ry. Co. has been incorporated, with a capital of $500,000. The purpose of the company is to connect Marion, Gas City and Jonesboro by cable or electric lines. The directors are J. V. Sweetser, Philip Matter, W. H. Carroll, G. G. Wharton and John T. Strange.

PEORIA, ILL.—Chartered, the Peoria St. Ry. Co.; capital stock, $100,000; to build and operate an electric street railway in Peoria; incorporators, Charles G. Paffer, Valentine G. Hietter, and L. M. Thurlow.

DEADWOOD, S. DAK.—The city authorities have granted a Beatrice, Neb., syndicate a franchise to construct an electric motor line through the city to Lead City, a distance of three miles. The road will be constructed inside 90 days.

HORSE AND MOTOR RAILWAYS.

LONG BRANCH, N. J.—The Third Avenue St. Ry. Co. has been incorporated with a capital of $100,000, and has made application to the board of commissioners for a franchise to construct a horse car line in Third Ave., from its intersection with Broadway, the principal business street in the town, to the station of the New York & Long Branch R. R. The incorporators are C. Asa Francis, Edward Hughes, Howard Green, Harry W. Green, Charles E. Clark and John D. Ivins.

DAYTON, O.—Chartered, Dayton Traction Co.; capital, $200,000; constructing street railroad in Dayton and Miamisburg.

JOPLIN, MO.—Chartered, Joplin & Rex City Ry. Co.; $50,000; operating street railway.

BRIDGES, TUNNELS AND CANALS.

BROOKLYN, N. Y.—The Bridge Construction Co. has been formed for the purpose of building bridges for all kinds of railways, including elevated and underground. The capital stock is $100,000, and the incorporators are Anthony Barrett, of Brooklyn; John Fox, Edward Lauterbach, and Simon Uhlman, of New York; Ernest C. Kieb, of Fanwood, N. J., and James Langan, of Brooklyn. The primary object of the company is to construct the proposed bridges across the East River between Brooklyn and New York.

HAVANA, ILL.—A bridge is being built at this point for the Jacksonville Southeastern R. R. by the King Bridge Co., of Cleveland, O. There is a draw span 300 ft., one span 250 ft., and one plate girder span 150 ft. Mr. L. M. Loss is the contractor for the foundations. Consult. Engr., E. L. Corthell, Chicago.

COLUMBIANA, ILL.—Plans for a bridge over the Illinois River prepared by E. L. Corthell, Chicago, have been approved.

NEW ORLEANS, LA.—Surveys and borings have been made for the New Orleans bridge, and plans are now being prepared to be submitted for the approval of the Secretary of War, by Mr. E. L. Corthell, M. Am. Soc. C. E., of Chicago, the consulting engineer. The charter calls for a main center span 1,000 ft. long in the clear at low water, and admits of only two piers 85 ft. in the clear above extreme high water. The grade of the bridge proper will be over 100 ft. above land on each side. It will be a double-tracked railroad bridge, and, including approaches, will be about two miles long. Mr. Corthell informs us that he has not as yet definitely decided upon the design for the superstructure.

HIGHWAYS.

MASSACHUSETTS.—The selectmen of Westborough have appointed Jas. Martin highway surveyor to have charge of the appropriation of $4,000 for highways and bridges.

CONNECTICUT.—The selectmen of East Hartford have been authorized to macadamize certain roads, and $32,000 appropriated for the work.

NEW JERSEY.—A committee of five has been appointed by the citizens of Verona to ascertain the cost per mile for macadamizing the streets of the township. It is proposed to issue bonds for $60,000 for road improvements.

MONTANA.—The commissioners of Cascade county will receive bids until April 20 for grading a county road. Howard Crosby, Co. Clk., Great Falls.

WATER-WORKS.

New England.

AUBURN, ME.—A long and exciting agitation over the proposed purchase of the works of the Auburn Aqueduct Co. has finally been brought to an end, it seems, by a vote of the stockholders to sell their works to the city.

BLAINE, ME.—Works are talked of.

CHICOPEE, MASS.—Surveys for the new reservoir and pipe line have been begun by Engr. E. C. Davis, Northampton.

DEER ISLE, ME.—The town is taking steps to secure works, it is reported. A supply from Pine Lake, a mile distant, is said to be available. Address Dr. F. E. Hitchcock, Chn. Bd. Hlth. of Rockland.

MELROSE, MASS.—The people have voted to apply to the legislature for authority to introduce an additional supply from Eel Pond, and to issue $75,000 4 bonds to pay for the same.

HAVERHILL, MASS.—The water commissioners have decided to introduce meters on factories and buildings in the shoe district of the city.

DARIEN, CONN.—Works are proposed by the Darien Water Co., in which Wm. B. Rider, Theophile Euphrat and W. B. Hoyt are interested.

Middle.

BROOKLYN, N. Y.—A contract has been awarded by the city for three 10,000,000-gallon vertical high duty Worthington pumping engines, to work against a head of 161 ft. Each of these engines will have two 25-in. high and two 50-in. low-pressure steam cylinders, and two 28-in. double acting water plungers, 28-ins. diam., all of 48 ins. stroke. They will have attached condensers. The engines are also to be furnished with a boiler plant, erected complete in the new Ridgewood pumping station, by Henry R. Worthington, New York.

CLIFTON SPRINGS, N. Y.—At the recent election a ticket in favor of works was elected. Wm. Lewellyn, Vil. Pres.

SOUTHAMPTON, N. Y.—Surveys for works have been begun under the direction of Engr. Chas. Brush, New York.

MANLIUS, N. Y.—Works are talked of. A small private plant has been in use since 1817.

YONKERS, N. Y.—The contract for building the new reservoir has been awarded to Dougherty & Berrigan, Yonkers. Further details are given under "Contract Prices."

KENSINGTON, PA.—Plans for works are being made by Jas. H. Harlow & Co. This is a new town of about 8,000 population, it is said, located 18 miles up the Allegheny River from Pittsburg.

LEBANON, PA.—Surveys for an addition to the water supply are being made by Cy. Engr. W. J. Burnside.

LIGONIER, PA.—Engrs. Jamison & Fogg, Greensburg, are making surveys for works in the interest of Greensburg parties. It is said that water will be introduced from a mountain source above Laughlinstown.

McSHERRYSTOWN, PA.—The McSherrystown Water Co. has been incorporated; $15,000; Treas., C. D. Smith.

WEST LEBANON, PA.—Surveys for works are in progress.

PINE GROVE, PA.—The borough is making arrangements for works. It is said that water will be brought from Adams Creek, near Lorberry Junction, about 2½ miles from Pine Grove, and that a contract to build a dam and lay five miles of pipe will be given out in a few weeks.

GEORGETOWN, DEL.—Works are proposed by the village commissioners.

Southern.

PIEDMONT, W. VA.—April 27 the people will vote on issuing bonds for works.

AIKEN, S. C.—It is stated that W. J. Oliver has been awarded a contract for a stand-pipe and laying mains.

MILAN, TENN.—Water-works and electric lighting plants are proposed.

North Central.

CADIZ, O.—A vote on building works will be taken.

GALLIPOLIS, O.—Works will be built by the town; estimated cost, $60,000.

LANCASTER, O.—Bids for an 18×85-ft. stand-pipe and for a mile or two of 6 and 4-in. pipe and 12 hydrants are wanted by the building committee of the Boys' Industrial School, about six miles from Lancaster.

OBERLIN, O.—Supt. W. B. Gerrish informs us that $5,000 of bonds have been voted for an elevated tank and main extensions.

AURORA, IND.—Seth Stedman, C. C. Stevens and E. H. Niebaum have been appointed a committee to gather information regarding the cost of works.

NORTH MANCHESTER, IND.—It is reported that works will be built. Address A. E. Stewart.

Northwestern.

BELLEVUE, IA.—Works are talked of. Address Mayor Roche.

HARTINGTON, NEB.—Engr. C. F. Loweth, St. Paul, Minn., informs us that bids for constructing works are wanted until April 14. There will be a 12×20-ft. brick well, 750,000-gallon duplex pumping engine, 4×14-ft. steel boiler with all appurtenances, 28×48-ft. brick veneered pumping station, with iron stack base, 20×24-ft. wooden tank on a 70-ft. wooden tower, 3,868 ft. of 4, 6 and 8-in. cast iron pipe, with specials, seven hydrants, one 8 and two 6-in. gates, with boxes. A. B. Gable, Chn. Vil. Bd.; C. F. Loweth, St. Paul, Minn., Engr.

Southwestern.

ST. LOUIS, MO.—Bids are wanted until April 25 for four 78-in. Belpaire firebox down draft boilers. Geo. Burnet, Pres.; E. S. Foster, Secy., Bd. Pub. Impvts.

Pacific.

ROCKPORT, WASH.—Works are projected with an artesian well as a possible supply.

SPOKANE, WASH.—Engr. C. B. Davis, Chicago, has made an exhaustive report on a new water supply for the city. He recommends that the supply be taken from the Spokane River, about four miles east of the city, and that water power be used.

LOGAN, UTAH.—A contract for cast iron pipe and specials has been awarded to the Colorado Fuel & Iron Co., and for valves to Rhodes Bros., both firms of Denver, Colo.; other fittings will be furnished by the National Tube Works, Chicago.

Canada.

DARTMOUTH, N. S.—The expenditure of $40,000 for water and sewerage systems is proposed.

AYLMER, ONT.—New works or improvements are said to be under consideration.

ARTESIAN WELLS.

EDDY, TEX.—A well is projected. Address J. T. Richardson.

IRRIGATION.

NEW COMPANIES.—Albuquerque Irrigation & Canal Co., Albuquerque, N. M.: $500,000; Alex. Sandoval, P. A. Simpson, Leasburg Canal & Irrigation Co., Las Cruces, N. M.: $200,000; Numa Raymond, J. D. Barncastle, Montecito Creek Water Co., Santa Barbara, Cal.: $25,000. Victoria Reservoir Co., Los Angeles, Cal.: $2,500,000; G. F. Piper, Duluth, Minn.; F. R. Sleeper, Des Moines, Ia.; Dr. J. Jarvis, Riverside, Cal.; L. M. Holt, Rialto, Cal.; C. J. Perkins, J. E. Mack and A. H. Koelig, San Bernardino.

SEWERS.

BROCKTON, MASS.—W. F. Cleaveland, ex-superintendent of the water-works, has been engaged by the sewerage commission to have general charge of the sewer work, under the direction of the engineer. Bids are asked in another column for pipe and construction of proposed sewers.

CAMBRIDGE, MASS.—Bids will be received until April 16 for 300,000 sewer brick. L. M. Hastings, Cy. Engr.

EASTHAMPTON, MASS.—We are informed by J. W. Wilson, town clerk, that a town meeting will be held April 17 to vote money for the sewerage system recently authorized by the legislature.

HOLYOKE, MASS.—The bill authorizing the issue of bonds for $250,000 for sewers in Elmwood and Oakdale has been signed by the governor.

MALDEN, MASS.—The street commissioners have requested that $150,000 be appropriated as soon as practicable for sewers.

WOBURN, MASS.—It is reported that work will soon be commenced on the sewerage system. It is proposed to do the work by day labor, employing only residents of the city, and to compare the cost with that by contract labor.

FORT PLAIN, N. Y.—A special election will be held April 15 to vote on the proposed sewer system; estimated cost, $16,000 to $22,000.

HERKIMER, N. Y.—F. K. Baxter, C. E., Utica, has prepared plans for about six miles of 8 to 20-in. pipe sewers, average cut, 8 ft., and the work will probably be advertised this month; estimated cost, $60,000.

IRVINGTON, N. Y.—The sewer commissioners will receive bids until April 22 for the construction of a sewerage system. See advertisement.

JAMESTOWN, N. Y.—The board of public works has been instructed to advertise for bids for the remaining portions of the sewerage system.

ONEIDA, N. Y.—A special election will be held April 18 to vote on the sewer question. The proposed system calls for 62,480 ft. of 8-in. pipe, average cut 8.3 ft.; 3,835 ft. of 9-in., same depth; 1,660 ft. of 10-in., cut 12.8 ft.; 1,890 ft. of 12-in., cut 9.5 ft.; 2,590 ft. of 15-in., cut 10¼ ft.; 6,060 ft. of 18-in., cut 13 ft.; also about 14,000 ft. of subsoil drain pipe; estimated cost, $146,000 to $175,000. E. L. Hunt, Clk. Sewer Comm.

TROY, N. Y.—The contracting board will receive bids until April 14 for a brick sewer in one street.

WATERTOWN, N. Y.—Fred Avery, Cy. Engr., informs us that plans have been prepared for 10,000 ft. of 8 to 24-in. pipe sewers, average cut 9 ft., for which bids have not been asked, and that more sewers may be ordered later.

KEARNY, N. J.—The township committee has instructed the clerk to advertise for bids for five sewers. Work has been begun on three, and the system is estimated to cost over $100,000.

BRIDGETON, N. J.—It is reported that bonds for $150,000 will soon be sold to construct the proposed system.

ALLEGHENY, PA.—The following lowest bids have been received: W. J. Dunn, $10,965; Sloan & McElwain, $7,500.

ERIE, PA.—Ordinances have been passed for about 2½ miles of 12 to 24-in. tile sewers. The only brick sewer for the coming season will be a 3-ft. sewer 1,350 ft. in length. Geo. Platt, Cy. Engr.

READING, PA.—The mayor has signed the ordinances providing for a complete system of sewerage, and appropriating $100,000 for a pumping station and disposal plant.

SCOTTDALE, PA.—The council has voted to ascertain the cost of a sewerage system.

CHARLOTTESVILLE, VA.—Rudolph Hering, New York, has been engaged to prepare plans for a system.

ROANOKE, VA.—The sewer committee has prepared plans for a sewer to cost $60,000.

MEMPHIS, TENN.—It is estimated that the proposed system of sewers in South Memphis will cost about $25,000. Col. Geo. E. Waring stated that the most feasible plan would be for the property holders to organize a private corporation to put in the system.

AKRON, O.—Plans have been prepared for a sewer to cost about $30,000.

CINCINNATI, O.—A contract has been awarded to Wilson & Strack, at $43,809.

INDIANAPOLIS, IND.—Resolutions have been adopted for a brick sewer 4,784 ft. in length and 42 × 63 ins. to 28 × 42 ins. in diameter.

OTTAWA, ILL.—Plans and estimates have been completed for a system of sewers in South Ottawa, to cost about $25,000.

COUNCIL BLUFFS, IA.—The council is considering plans and specifications of the city engineer for important sewer work.

ST. JOSEPH, MO.—The city engineer has been instructed to have sewers constructed in two districts.

PALESTINE, TEX.—The City of Palestine Sewerage Co. has been incorporated by Timothy Hurley, B. W. Homans and others; capital stock, $100,000.

SALT LAKE CITY, UTAH.—The board of public works and city engineer have been authorized to advertise for bids for the proposed gravity sewer, for which $300,000 has been appropriated.

FRUITVALE, CAL.—The proposed issue of bonds for $30,000 for sewers will be voted upon April 15.

OAKLAND, CAL.—Marsden Manson and C. E. Grunsky, engineers to whom the city council referred the plans for a sewer on the east side of Lake Merritt, have reported in favor of the plans of the city engineer.

PASO ROBLES, CAL.—A committee has been appointed to investigate the question of a sewer system and the proposed issue of sewer bonds for about $60,000.

SALINAS, CAL.—Plans have been adopted for a sewer system estimated to cost about $30,000.

STREETS.

GLOUCESTER, MASS.—The committee on highways will receive bids until April 12 for 2,500 lin. ft. edgestones, 200 stone bounds; also for Philadelphia paving blocks, 9 to 14 ins. long, 6 to 7 ins. deep, 3½ to 4½ ins. wide, and to lay 22 to the yard, for paving Pearce St.

NEW YORK, N. Y.—The commissioner of public works will receive bids until April 11 for seven contracts for paving with asphalt on the present stone block pavement. Contracts for asphalt paving have been awarded to the Barber Asphalt Paving Co. aggregating about $245,000, and to the Sicilian Asphalt Paving Co. $110,000.

OLEAN, N. Y.—The lowest bids for paving four streets with brick were those of Park, Simpson & Albrecht, Olean, at about $50,000.

SOUTH BOSTON, VA.—Bids will be received by the mayor until April 10 for paving and curbing.

CLEVELAND, O.—The lowest bids for paving nine streets with Medina sandstone were those of L. & J. F. Brennan, about $315,000; only bids for paving three streets with asphalt, Warren-Scharf Asphalt Paving Co., about $118,000. From 11 to 19 bids were received for each of the contracts for paving with brick; in three streets, Roehl Bros. being lowest, at about $220,000, and in two streets, Roehl & Warden, at about $27,500.

SANDUSKY, O.—The lowest bid for paving Market St. was that of Jacobs & Stewart, Norwalk, $7,436 to $9,267, according to material.

TOLEDO, O.—The city clerk will receive bids until April 17 for paving several streets.

INDIANAPOLIS, IND.—Resolutions have been adopted for paving three streets with asphalt. The city engineer is preparing specifications for brick paving.

MUNCIE, IND.—The city clerk will receive bids until May 1 for paving three streets with Trinidad Lake asphalt.

TURNER, ILL.—A boulevard about two miles in length is being surveyed. It is to be 85 ft. wide and macadamized.

WHITEFISH BAY, WIS.—The village board will receive bids until May 1 for work in Day Ave.

MINNEAPOLIS, MINN.—Bids are to be asked for paving 36,000 sq. yds. with cedar blocks and 3,000 sq. yds. with brick, also for 15,000 sq. yds. of stone curbing. The council is considering a proposition to have city work done by day labor and not by contract.

MUSCATINE, IA.—The commercial club has started a movement for paving the streets with brick.

SALT LAKE CITY, UTAH.—The contracts for paving West Temple St. with stone blocks and asphalt has been awarded to the Pacific Paving Co., at $72,830. The bids will be published next week.

TACOMA, WASH.—The city engineer has prepared specifications for paving Pacific Ave. with fir blocks, at an estimated cost of $72,000. There will be 6 ins. of concrete with the surface floated and smoothed with cement mortar, and upon this will be laid the blocks, 4½ ins. thick, 3 ins. wide and 7 to 10 ins. long, the grain of the blocks being vertical. The joints are to be ¾ in. wide, filled to a height of ½ in. with tar and asphalt and then filled with cement grout.

ELECTRICAL.

DALTON, N. H.—Bids are being received for constructing a dam across the Connecticut River near this place. Address C. B. Dalton, Box 856, Portland, Me. Mr. Dalton is secretary of the Coos & Grafton Electric Light & Power Co., to which the item from this town in our issue of last week referred. We are informed that the main office will be at Lancaster, and that it is proposed to furnish light, heat and power to Lancaster, Littletown, Whitefield, Bethlehem, Jefferson, Dalton, and St. Johnsbury, Vt.

PAWTUCKET, R. I.—Both branches of the city council have passed a resolution providing for the appointment of a committee to investigate the cost of building and maintaining a municipal electric light plant.

BROOKLYN, N. Y.—The contracts of the Citizens' Electric Illuminating Co. and the Municipal Electric Light Co. have been renewed at the present price, $182.50 per year for each arc light. The contracts with the different companies for gas lighting were also renewed at the present prices.

MIDDLETOWN, DEL.—Bids are asked until April 10 for a 70-HP. boiler, 75-HP. engine, two dynamos for 100 lights of 24-c. p., and 1,200 of 16 c. p., switchboard, wire, etc. John W. Jolls, Secy. Light and Water Com.

NORTH EAST, MD.—It is reported that the town commissioners are negotiating with the Reis Specialty Co., Baltimore, for an electric light plant.

BERKELEY SPRINGS, W. VA.—The Berkeley Springs Water-Works & Improvement Co. desires bids for 1,000 incandescent lights.

YOUNGSTOWN, O.—The council has decided to submit the question of a municipal electric light plant to a vote of the citizens.

CHARLEVOIX, MICH.—We are informed by E. M. Guard, Supt. of Water-Works, that the citizens have voted down the electric light project, which postpones the question another year.

ALTON, ILL.—The new electric light company has received the contract for street lighting, at $100 per year for each lamp for the first 70, and $90 per year for each additional light, the lights to burn all night.

FARGO, N. DAK.—J. T. Graves, Cy. Engr., informs us that a franchise has recently been granted to a new company, but that so far nothing else has been done. The present lighting contract has two years more to run.

ST. CHARLES, MO.—The committee on ways and means has reported that the municipal plant is inadequate to supply the increased demand for lights; also that a new boiler is needed.

JACKSON, CAL.—Richard Webb is organizing a local company to put in an electric light plant.

STOCKTON, CAL.—The Stockton Power Transmission Co. has been incorporated with a capital of $1,000,000 to generate electricity by water power on the Mokelumne River, 42 miles distant, and transmit it for sale to manufacturers. The company will also supply electricity for a railroad between this city and Lodi.

MONTCLAIR, N. J.—At the annual citizens' meeting held April 4, report was adopted recommending that the township committee obtain estimates of the cost of constructing and operating a municipal electric lighting plant for public and private lighting; and also the most favorable terms upon which a company would build and operate a plant. Montclair is a suburb of New York, with a population of about 10,000, and the assessed valuation is about $5,000,000. A local company has applied for a franchise.

NEW COMPANIES.—The Heat, Light & Power Co. of New Jersey, Trenton, N. J.: $200,000; J. H. Scudder, E. V. Richards, D. Mackenzie. National Electric Lamp-Lighter Co., Chicago, Ill.: $50,000; J. C. Chambers, P. F. Stanley, W. J. Culver. Consolidated Electric Co., Chicago, Ill.: $50,000; L. B. Scott, C. P. Emmons, C. Orkamp. Electric Gas Lighter & Specialty Co., Chicago, Ill.: $50,000; A. M. Sloss, Louis Stein, Boston Chemical Electric Co., Chicago, Ill.: $200,000; B. H. Ottinger, H. W. Peck, T. J. Lesiens. Queen Electric Co., Chicago, Ill.: $15,000; A. Bennett, J. F. Schaffer, H. G. Hinkle. The De Pere Electric Light & Power Co., De Pere, Wis.: $20,000; J. P. Dausman, J. S. Chase, William Armstrong. The company has a contract with the city for lighting the streets.

CONTRACT PRICES.

DREDGING.—Buffalo, N. Y.—The following bids were received for dredging in the Buffalo River: Chas. F. Dunbar, $2.40 per cu. yd. for rock, and 45 cts. for earth; Carkin, Stickney & Cram, $2.57 and 35 cts.; McNaughton & Banst, $2.47 and 24 cts.; Hingston & Woods, $2.98 and 30 cts.

GRANITE BLOCKS.—Springfield, Mass.—The contract for 10,000 sq. yds. of granite blocks for paving has been awarded to the Flint Granite Co., Monson, at $1.60 per sq. yd. The only other bid was that of the Hudson & Chester Granite Co., $1.62.

ASPHALT PAVING.—Erie, Pa.—A contract for paving with asphalt has been awarded to the Erie Paving Co., at $3 per sq. yd., with a guarantee for ten years. The Trinidad Asphalt Co., New York, bid $3.15.

BRICK PAVING.—Goshen, Ind.—Sixteen bids were received for the proposed paving. The lowest are reported as follows: Edward Avers, Zanesville, O., $1.14 per sq. yd. for South Zanesville brick, and 16 cts. per cu. yd. for excavating; South Bend Construction Co., $1.13 for Canton shale brick, and 19 cts.; J. E. McKinney, Toledo, O., $1.20 for Canton fireclay brick, and 12 cts.

ASPHALT AND BRICK PAVING AND SEWERS.—Dayton, O.—We have received from G. B. Pike, Asst. Cy. Engr., a statement of the bids received March 27 for six paving contracts, about 48,650 sq. yds. We print the bids received for the work in Wayne Ave., 20,500 sq. yds., the bidders being as follows: 1. M. G. Cain & Co., Dayton; 2. Funk & Coleman, Springfield; 3. J. Delaney, Cincinnati; 4. A. B. Smith, Springfield; 5. Ed. Ryan, Springfield; 6. Standard Construction Co., Columbus; 7. G. W. Foster, Cincinnati:

	1.	2.	3.	4.	5.	6.	7.
Curbing, 21-in., per lin. ft.	$.63	$.65	$.68	$.75	$.60	$.68	$.70
" 24-in.	.68	.70	.74	.85	.68	.75	.75
Paving, first-class Medina stone, per sq. yd.	3.04	4.04	....	....	3.99	....	2.77
" Hayden block, " "	2.62	2.51	....	....	2.49	....	....
" Hallwood block, " "	2.53	2.42	....	....	2.44	....	....
" about 25 varieties of brick, " "	2.23 and 2.24	2.10 to 2.40	2.45 to 2.70	2.22 to 2.43	2.235 to 2.44	2.25 to 2.35	....
Sewers, 18-in., per lin. ft.	.74	.90	1.15	.80	.85	.75	.80
" 24-in., " "	1.38	1.35	2.00	1.30	1.34	1.58	1.30
Catch basins, each	23.00	27.00	30.00	30.00	27.75	30.00	35.00
Manholes, "	45.00	25.00	25.00	25.00	25.00	25.00	30.00
Culverts, curb, per lin. ft.	.75	1.50	.65	1.50	.30	1.00	.75
" paving, per sq. yd.	2.50	2.25	2.60	2.25	2.44	2.50	2.00
Repairing pavement, per sq. yd.	3.50	3.00	3.00	4.50	2.00	1.25	5.50

In the other streets bids were also received for paving with asphalt, and were as follows: Trinidad Asphalt Co., Dayton, $2.73 to $2.83 per sq. yd.; Warren-Scharf Asphalt Paving Co., New York, $2.75 to $2.78.

STREET SUPPLIES.—Baltimore, Md.—Contracts have been awarded as follows: Stewart R. Carr & Co., iron gutter plates, 1.2 cts. per lb.; J. P. Curley, flagstones, 28 cts. per sq. ft., and Belgian blocks, $1.50 per sq. yd.; Chas. H. Harris, cobblestones, $1.75 per perch; J. H. Atkinson, gutter stones, 26 cts. per lin. ft.

CEMENT.—Portland, Me.—The following bids were received by Lieut.-Col. Peter C. Hains, U. S. Engineer Office, for 15,000 bbls. hydraulic cement: J. H. Carleton, Portland, $1.23 per bbl.; Lawrenceville Cement Co., New York, N. Y., $1.15; National Building Supply Co., Baltimore, Md., $1.50; F. O. Norton Cement Co., New York, N. Y., $1.25; C. S. Chase, Portland, $1.29; W. G. Nash, Boston, Mass., $1.15.

CEMENT AND STONE.—Boston, Mass.—The following bids were received by Lt.-Col. S. M. Mansfield, U. S. Engineer Office, for 10,000 bbls. American hydraulic cement: Bryant & Kent, Boston, 94 cts. per bbl.; W. G. Nash, Boston, 94 cts.; Ham & Carter, Boston, 97 cts.; Waldo Bros., Boston, 94¾ cts.; Lawrenceville Cement Co., New York, N. Y., $1. The lowest bid for 3,000 tons rubble stone was that of Edwin Canney, Pigeon Cove, 93 cts. per ton; and the lowest bid for 10,000 tons broken stone, Massachusetts Broken Stone Co., Boston, $1.34 per ton.

Fort Monroe, Va.—The following bids were received by Maj. Chas. E. L. B. Davis, U. S. Engineer Office, for cement: Lawrenceville Cement Co., New York, N. Y., 95 cts. per bbl.; Lawrence Cement Co., New York, N. Y., 95.58 cts.; S. H. Hawes & Co., Richmond, 98 cts.; Geo. L. Neville, Portsmouth, $1.11 40-100; New York & Rosendale Cement Co., New York, N. Y., $1.15; National Building Supply Co., Baltimore, Md., $1.14; F. O. Norton Cement Co., New York, N. Y., $1.14. The contract for broken stone was awarded to Chas. G. Smith & Son, Washington, D. C., at $1.97 per cu. yd.

SEWERS.—Boston, Mass.—Bids were opened March 25 for two sections of the metropolitan main sewer, and the lowest bids noted last week. Section 29 is in Cam-

bridge; length, 5,150 ft.; average cut to 8 ins. below invert, 17 ft.; maximum outside width of masonry, 72 ins. Section 45 is in Winchester; length, 6,500 ft.; average cut to 8 ins. below invert, 8.3 ft.; maximum outside width of masonry, 40 ins. The total bids were as follows: Everson & Liddle, Providence, R. I., $60,202 for section 29 and $18,307 for section 45; Jones & Meehan, Jamaica Plain, $54,632 and $22,610; Chas. Lineham, Cambridge, $48,490 and $19,305; Lindsay & Cudmore, Somerville, $47,534 and $16,719; section 29 only,—Malone & Tallent, Everett, $44,327; National Construction Co., Boston, $53,800; H. P. Nawn, Boston, $52,200; section 45 only,—Geo. F. Herrey & Co., Boston, $34,097; McCarthy & Helrich, Everett, $23,835; Wm. B. Bryne Everett, $22,623; Andrew W. Bryne, Somerville, $21,575; Dennis O'Connell, Dorchester, $20,505; Frank L. Align, Worcester, $19,305. The prices ranged as follows: Section 29, A, earth excavation and refill, $2.75 to $6.40 per lin. ft.; B, brick masonry, American, $12 to $13 per cu. yd.; C, Portland, $13.50 to $16; D, concrete masonry, American, $4 to $5.50; E, Portland, $6.50 to $7.50; F, spruce lumber in place, $28 to $40 per M. ft. B. M.; spruce piles driven, 17 to 22 cts. per lin. ft.; section 45, A, 85 cts. to $3.25; B, $12 to $15; C, $14 to $17; D, $4.75 to $6.50; E, $6 to $8; F, $30 to $50.

RESERVOIR.—Yonkers, N. Y.—The following bids were received for building a distributing reservoir, the price in the first column being for pavement laid in cement, and with concrete in bottom of reservoir, and the other being for pavement laid dry without concrete in bottom:

Hendrick & Latham, Easthampton, Mass.	$309,100	$174,350
Jas. Flanagan, New York	216,706	182,831
R. A. Malone & Co., Lancaster, Pa.	150,350	122,475
Sessions & Blake, New York	138,044	104,169
Isaac T. Brown, New York	172,507	138,582
Dougherty & Berrigan, Yonkers	148,807	127,707
P. F. O'Hehir, Warwick	193,200	157,875
J. & G. Stewart, Yonkers	183,212	152,962
O'Connor & Overman, New York	190,000	156,375
Hart & McBride, Dobbs Ferry	214,242	153,242
Molloy Bros., New Rochelle	157,555	128,805
L. E. Miner & Co., New York	190,056	158,306
J. P. Cranford & Co., Brooklyn	199,160	171,225
Troy Public Works Co., Troy	164,905	127,155
Bracey & Maurer, Yonkers	171,057	133,872
Pennell, O'Hern & Co., Yonkers	168,127	139,102
S. W. Frescoln, New York	173,945	152,120
D. V. Murphy, Yonkers	189,857	155,107
Washburn & Washburn, Purdy's Sta.	160,180	128,855

The contract was awarded March 29 to Dougherty & Berrigan, at the following prices: Grubbing and cleaning 12 acres, at $100; 7,000 cu. yds. excavation foundations, at 60 cts.; 25,000 cu. yds. rock excavation, at $1.40; 60,000 cu. yds. earth excavation, at 20 cts.; 70,000 cu. yds. embankment, at 20 cts.; 2,800 cu. yds. concrete, at $6.50; 6,000 cu. yds. concrete bottom in reservoir, at $6; 10 cu. yds. first class masonry with common cement, at $22; 50 cu. yds. with Portland cement, at $24; 5,000 cu. yds. second class masonry with common cement, at $3; 300 cu. yds. with Portland cement, at $7; 350 cu. yds. third class masonry, at $4; 100 cu. yds. brick masonry, at $13; gate-house complete, $14,500; 15,500 cu. yds. pavement of slopes, at $1.65 in cement, or $1.50 laid dry; 500 sq. ft. bluestone, at 40 cts.; 425,000 lbs. pipe and castings, laid or set, at $15 per 1,000 lbs.; 10,000 ft. timber and plank, $40 per M. ft.; 1,000 sq. yds. gutter pavement, at 75 cts.

SWING BRIDGE.—New York, N. Y.—The department of public works, New York city, opened bids March 28 for the construction of the swing bridge over the Harlem ship canal, at Kingsbridge, N. Y., of which we give a description in our issue of March 9. There were five bidders: 1, McMullan & Breuchaud; 2, Christie & Lowe; 3, Steward & McDermott; 4, Sooysmith & Co.; 5, T. & A. Walsh. The contract has been awarded to McMullan & Breuchaud. The bids contain 34 items, of which we give the more important ones in the following table. It will be noted that T. & A. Walsh bid $4.25 per lb. for iron, which was very evidently a mistake for 4.25 cts., but indicates the necessity of great care in filling up blanks in making bids:

Tenders for Construction of Kingsbridge Road Bridge, N. Y.

Items.	Quantities.	McMullan & Breuchaud.	Christie & Lowe.	Stewart & McDermott.	Sooysmith & Co.	T. & A. Walsh.
		1.	2.	3.	4.	5.
Pneumatic work, with concrete filling, per cu. yd	2,100 cu. yds.	$39.00	$31.75	$37.50	$33.00	$32.00
Cofferdam masonry, per cu. yd. of masonry	350 " "	27.50	26.75	30.00	30.00	21.50
Piling, per pile	200 piles	8.00	12.00	12.00	12.00	9.00
Excav. for crib fender, per cu. yd	1,000 cu. yds.	1.00	2.00	1.40	2.50	.50
Rip-rap filling for crib fender, per cu. yd.	500 " "	.75	1.25	.90	1.00	.60
Crib fenders, excl. planking, per cu. ft.	200,000 " ft.	.06¾	.06	.09	.08	.06½
Fender planking and bracing, per M. B. M.	100 M. B. M.	40.00	35.00	45.00	30.00	40.00
Masonry, pier I. and III., granite ab. M. L. W., per cu. yd	1,320 cu. yds.	21.00	20.10	25.00	26.00	22.50
Masonry, pier I. and III., limestone above M. L. W., per cu yd	1,320 " "	15.00	15.00	15.00	17.00	16.50
Masonry, pier II., granite ab. M. L. W., per cu. yd	1,896 " "	14.00	14.00	20.00	20.00	13.50
Masonry, pier II., limestone ab. M. L. W., per cu. yd	1,896 " "	10.50	12.20	10.50	12.50	12.25
Masonry, abtmts., granite ab. caissons, per cu. yd	3,325 " "	13.50	18.15	20.00	22.00	21.28
Masonry, abtmts., limestone ab. caissons, per cu. yd	3,325 " "	11.50	14.40	10.50	15.00	16.50
Granite coping, per cu. ft.	4,600 " ft.	2.50	2.07	2.30	2.00	2.30
Granite pedestals, newels, complete, per cu. ft.	2,020 " "	2.10	2.75	2.30	2.50	3.65
Dressed masonry surfaces, per sq. ft.	4,500 " "	.85	.90	.85	.75	.85
Metal, draw span, per lb.	847,000 lbs.	4.1 cts.	4.21 cts.	.04	.05	*4.25
Metal, turn table, per lb.	281,000 "	5.6 "	6.66 "	.06	9.15 cts.	6.75 cts.
Metal, fixed spans, per lb.	608,000 "	4 "	3.93 "	.04	4.65 "	3.97 "
Machinery and fixtures, complete		14,000.00	16,169.00	17,000.00	17,776.00	16,160.00
Fitting engine room, complete		1,500.00	2,200.00	2,500.00	2,420.00	2,200.00
Railing, per lin. ft.	924 lin. ft.	6.00	7.00	7.25	5.02	7.00
Single-light lamps, with brackets, each	16	50.00	35.00	37.00	22.00	35.00
Three-light cluster lamps, with posts, each.	12	125.00	125.00	130.00	81.40	125 00
Rock asphalt sidewalks, per sq. yd	805 sq. yds.	2.65	4.00	2.85	2.92	2.65
Rock asphalt roadway, per sq. yd	2,178 " "	3.45	4.00	3.95	3.80	3.45
Flagging, per sq. ft.	3,000 " ft.	.20	.25	.25	'26.4 cts.	.45
Curbing, per sq. ft.	1,000 " "	.40	.55	.50	74.2 "	.90
Earth filling, per cu. yd	110,000 cu. yds.	.20	.40	.39	.45 "	.32
Totals (with granite above M. L. W.)		$358,132	$404,942	$447,089	$468,965	$3,974,544
Totals (with limestone above M. L. W.)		334,926	382,629	384,289	419,590	3,947,966

* Probably an erroneous bid.

MISCELLANEOUS.

LOCK AND DAM.—Charleston, W. Va.—Bids will be received until April 25 and 26 for locks Nos. 10 and 11 of the Great Kanawha River improvement. The bids recently received for this work were published in our issue of March 16. Col. Wm. P. Craighill, U. S. Engineer Office.

DAM.—Lonsdale, R. I.—The contract for a dam across the Blackstone River at this place has been awarded by the Lonsdale Co. to J. T. Tank, Providence. The dam is to be about 400 ft. long, built of granite, with cut granite face and coping, and five cut granite archways in the gate chamber, and will cost over $100,000.

LOCK.—Albany, N. Y.—The superintendent of public works has awarded the contract for rebuilding lock No. 76, on the Black River Canal, to J. J. Hallock, Syracuse, at $12,535. The other bids were J. E. Pidgeon, Albany, $12,708; F. Louis Foass & Co., Utica, $12,878; J. T. Campbell, Lowville, $18,096; Hughes Bros., Syracuse, $19,936.

JAIL.—Bakersfield, Cal.—The supervisors of Kern county will receive bids until May 20 for a county jail. Plans may be seen at the office of Salfield & Kohlberg, 339 Kearny St., San Francisco.

DREDGING AND IRONWORK.—New York, N. Y.—The department of docks will receive bids until April 13 for dredging about 73,250 cu. yds. from piers on the East River; also for an iron awning shed, with appurtenances, requiring about 38,700 lbs. structural iron, etc.

GARBAGE DISPOSAL.—New York, N. Y.—No bids were received April 4 for disposing of street refuse for five years, and the time for receiving bids was extended until April 13. The material dredged out of river slips by the department of docks is included in the contract, the total material being estimated at 3,175,800 cu. yds. annually.

ROCK EXCAVATION.—Chicago, Ill.—C. T. Mason, 100 Washington St., desires bids until April 15 for 70,000 cu. yds. of rock excavation. See advertisement.

GAS COMPANY.—Newark, N. J.—The New Jersey Light & Heat Co., recently incorporated, with a capital of $2,000,000, is reported as either to lease the gas plants in this city or to erect one in Harrison, to supply Jersey City, Hoboken, Newark, Elizabeth, and the Oranges. Geo. R. Gray is one of the incorporators.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., have completed 5 express passenger engines for the Lake Shore & Michigan Southern, and have an order for 8 freight engines for the Cleveland, Lorain & Wheeling. The Cooke Locomotive & Machine Works, Paterson, N. J., are building 14 ten-wheel engines for the Southern Pacific and 6 eight-wheel passenger engines and 2 switching engines for the Chicago & Grand Trunk. The Richmond Locomotive & Machine Works are building 10 ten-wheel engines for the Cleveland, Cincinnati, Chicago & St. Louis, and 2 eight-wheel engines for the Chesapeake & Ohio. The Chicago & West Michigan will add 10 ten-wheel freight engines and 4 six-wheel switching engines to its equipment. The Baltimore & Lehigh will shortly place orders for 12 engines.

CARS.—The Barney & Smith Car Co., Dayton, O., is building 250 cars for the Merchants' Dispatch.—The St. Charles Car Works, St. Charles, Mo., are building 20 day cars, 10 chair cars and 4 mail cars for the Missouri Pacific and 10 excursion cars for the Salt Lake & Los Angeles.—The Terre Haute Car Mfg. Co., Terre Haute, Ind., is building 50 Jennings patent poultry cars for the Live Poultry Transportation Co.—The Missouri Car & Foundry Co., St. Louis, Mo., is building 200 Cudahy refrigerator cars.—The Baltimore & Lehigh will purchase standard gage equipment in consequence of its change of gage.—The Chicago & West Michigan will add to its equipment 1,000 box cars of 60,000 lbs. capacity, 200 flat cars, 10 passenger cars and 7 cabooses.—The Florida Central & Peninsular is building a large number of box and flat cars at its Fernandina car shops.—The Pennsylvania is building 20 baggage cars at its own shops.—The Standard Car Co., Milwaukee, Wis., has been incorporated by N. Merrill, Ezra Dederick and F. N. Merrill; $100,000.

THE HAWLEY DOWN DRAFT FURNACE CO., Chicago, has removed its general offices to the Security Building. It reports in the past three months a sale of over 200 furnaces in Chicago, making a total of about 400 Hawley furnaces now in use in that city. Mr. S. T. Bleyer, Gen. Mgr., states that the company has contracted for furnishing boilers of 20,000 HP. equipped with Hawley furnaces for the Chicago & St. Louis Electric Ry., and for equipping a 3,000 HP. plant of Stirling boilers with these furnaces for the Lindell Electric Ry., of St. Louis.

THE STIRLING BOILER CO., Pullman Building, Chicago, has contracted to furnish the Lindell Electric Ry. Co., St. Louis, Mo., with a 3,000 HP. boiler plant, and the Lafayette (Ind.) St. R. R. Co. with a 250 HP. boiler plant.

THE NEW YORK FILTER CO. reports a prosperous business, having in the last year erected and put in operation five new water-works filter plants, the largest of which, at New Orleans, La., has a capacity of about 20,000,000 gallons per day. It has also put in additional plants, increasing their capacity in eight other cities, the largest of which was Atlanta, Ga., 4,000,000 gallons increase. The Board of Directors at the annual meeting in March declared a dividend on the capital stock, which will be payable in May. The present year is said to show a still greater activity in the filtering business, the sales booked during March, 1893, being double those booked during March, 1892.

THE RIEHLE BROS. TESTING MACHINE CO., Philadelphia, Pa., reports the following among very recent orders: American Telephone & Telegraph Co., New York, 30,000-lb. vertical screw power testing machine. Syracuse Water Board, Syracuse, N. Y.; Riehle U. S. standard 1,000-lb. cement testing machine, with molds, sieves, mixing table, and special appliances. Metropolitan West Side Elevated R. R. Co., Chicago, Ill., 1,000-lb. U. S. standard cement testing machine, with worm gear and rubber nolated grips, and sundry special appliances. Leland Stanford, Jr., University, Palo Alto, Cal., 20,000-lb. vertical screw power testing machine, with indicator. Chicago, St. Paul, Minneapolis & Omaha Ry. Co., St. Paul, Minn., 150,000-lb. screw power testing machine, with vernier poise beam and tools for tensile, compression, and transverse strains. Maine State College, Orono, Me., 60,000-lb. vertical screw power machine. University of California, Berkeley, Cal., 5,000-lb. transverse testing machine, with indicator for elastic limit. Madison Car Co., Madison, Ill., 5,000-lb. transverse testing machine, with indicator. Ewart Mfg. Co., Indianapolis, Ind., 20,000-lb. horizontal screw power testing machine. L. Hilgartner & Son, Baltimore, Md., marble basin hole cutter. A. Piamondon Mfg. Co., Chicago, Ill., 3,000-lb. transverse testing machine, with indicator. Gillett-Hertzog Mfg. Co., Minneapolis, Minn., 5,000-lb. transverse testing machine with indicator, for testing specimens 48 ins. long.

PUMPING ENGINES.—The firm of Henry R. Worthington, New York, reports recent installations of waterworks pumping machinery, as follows: Bear Gap Water Co., Shamokin, Pa., high-duty engine of 1,400,000 gallons daily capacity, against a head of 700 ft. Shamokin, Pa., Water Co.; compound condensing engine of 1,250,000 gallons capacity. Brooklyn, N. Y.; compound condensing, 5,000,000 gallons. Columbia, S. C.; 2,000,000 gallons. Butte, Mont.; 2,500,000 gallons. Sayre, Pa.; triple expansion condensing, 3,000,000 gallons. Athens, Ga.; two compound condensing, each 1,500,000 gallons. Flatbush, L. I.; compound condensing, 3,000,000 gallons.

THE W. E. CALDWELL CO., Louisville, Ky., reports 280 cypress tanks shipped in six weeks to 18 states and to Cuba. The majority of them were equipped with the company's special Scott patent draw lugs.

THE JOHNSON RAILROAD SIGNAL CO., Rahway, N. J., informs us that it has a contract from the Chicago & Northern Pacific R. R. Co. (E. J. Pearson, Principal Assistant Engineer), for interlocking plant at Harvey, at the crossing of the Chicago Central, Chicago & Grand Trunk and Illinois Central railways. The plant will have 50 working levers.

NEW COMPANIES.—Robinet Hydraulic Motor Co., Chicago, Ill.; $100,000; W. H. Robinett, G. W. Seifidge and George A. Masters. Gordon Railway Signal Co., Denver, Colo.; $250,000; Angus C. Gordon, J. D. McMasters and E. B. Fenner. Hill & O'Meara Construction Co., St. Louis, Mo.; $25,000; John Hill, J. B. O'Meara, James Shannon and C. V. Mercereau. Duplex Electric Trolley Mfg. Co., Chicago, Ill.; $100,000; E. P. Hovey, James McTyner and P. L. Austin. Highland Brick & Tile Works Co., Edwardsville, Ill.; $6,000; Henry Piniker, Otto Schott. Central Tie & Cedar Block Paving Co., Chicago, Ill.; $150,000; James M. Wilson, T. J. Mullen and Ira S. Baker. Clements Bros. Construction Co., Cleveland, O.; $1,000,000; Pres., William L. Clements; Secy., C. H. Lewis. Worcester Construction Co., Worcester, Mass.; $20,000; to build street railways; Pres., C. A. Richardson; Secy., W. L. Kendall. Church Paving Co., Chicago, Ill.; $20,000; B. S. Church, James E. Church and B. L. Davis. Stuart Firebrick Co., Pittsburg, Pa.; $20,000; A. P. Childs, A. J. Wurts and W. H. Rea.

PROPOSALS FOR WATER-WORKS CONSTRUCTION.

Sealed bids will be received by the Board of Trustees of the Corporation of Rochester, Ind., up to noon on April 25th, 1893, and opened at 8 p. m. the same day, for the construction of a complete system of water-works for said corporation. There will be required about 7¼ miles of mains, 80 hydrants, two pumps, two boilers, steel stand-pipe, brick pumping station and chimney, inlet well, etc. Bids will be received for the materials and work separately or for the works constructed complete. Each bid must be accompanied by a certified check or its equivalent. The amount is named in the general specifications. The plans may be seen and specifications procured at the office of the Clerk of the Board of Trustees, Rochester, Ind., or at the office of the Engineers, Voorhees & Witmer, Rooms 65 and 66 Chapin Block, Buffalo, N. Y.

The right will be reserved to reject any and all bids. DARIUS AULT,

D. S. ROSS, Clerk.

President of Board of Trustees.

Rochester, Ind., March 23d, 1893. 13-2t

NOTICE TO PAVING CONTRACTORS.

Sealed proposals will be received by the City Clerk of Carbondale, Pa., until Monday, April 10th, 1893, at 5 o'clock p. m., for the furnishing of material and labor for the paving and curbing of Dundaff St. and Salem Ave. with vitrified brick on a concrete base according to plans and specifications on file in the City Engineer's Office.

Bidders will be required to inclose a certified check of three hundred dollars ($300.-00) as a guarantee of good faith and that they will enter into a contract within 10 days if awarded the same.

The city reserves the right to reject any or all bids. R. D. STUART,

WALTER FRICK, City Clerk.

City Engr. 12-3t

PROPOSALS FOR BRIDGE SUB-STRUCTURE.

Sealed proposals will be received by the Board of Public Works of the City of Bridgeport, Conn., until Friday, April 21st, 1893, at 6 p. m., for the furnishing of all material and labor required in the construction of masonry substructure for new bridge, as follows:

793 cubic yards first class coursed ashlar masonry.

517 cubic yards second class coursed masonry.

400 cubic yards rubble retaining wall.

Specifications may be seen and full particulars obtained at office of H. G. Scofield, City Engineer.

Bidders required to inclose a certified check of five hundred dollars, as a guarantee of good faith.

The Board reserves the right to reject any or all bids.

All proposals to be addressed to the undersigned:

BERNARD KEATING, Clerk,

Bridgeport, Conn., March 28, 1893.

13-3t Room 10, City Hall

PROPOSALS FOR CAST-IRON WATER PIPE AND SPECIAL CASTINGS.

Sealed proposals will be received at the office of the Syracuse Water Board, City Hall, Syracuse, N. Y., until 2 o'clock p. m. of the 14th day of April, 1893, for furnishing and delivering on platform cars in the City of Syracuse:

1	ton (of 2,000 lbs.) of		36-inch	straight	pipe
20	"	"	30	"	"
1	"	"	20	"	"
25	"	"	16	"	"
20	"	"	12	"	"
10	"	"	10	"	"
55	"	"	8	"	"
30	"	"	6	"	"
1	"	"	4	"	"

36,000 lbs. cast iron special castings.

The delivery of the pipe and specials must commence in fifteen days, and be wholly completed within fifty days from the date of the execution of the contract.

The successful bidder will be required to execute the contract with the required surety, in the sum of $800, in five days after notice that the work has been awarded to him.

Blank forms of contract, specifications, bond and proposals, can be obtained at the Engineer's Office of the Syracuse Water Board, Room 8, Granger Block, in said city on application.

Proposals should be indorsed, "Tenders for Water Pipe," and be addressed to the undersigned: JAMES B. BROOKS,

Secretary Syracuse Water Board, City Hall, Syracuse, N. Y.

Syracuse, N. Y., March 28th, 1893. 13-2t

UTICA PIPE FOUNDRY CO.

CAST IRON PIPE AND SPECIALS FOR WATER AND GAS.

Also flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, etc. CHAS. MILLAR & SON, Selling Agents, Utica, N. Y. Manufacturers of Lead Pipe and Plumbers' Materials. Wholesale Eastern Agents Akron Vitrified Sewer Pipe.

MONTAGUE & COMPANY,

MANUFACTURERS

FIRE BRICK, SEWER PIPE,

DOUBLE STRENGTH

RAILROAD CULVERT PIPE.

CHATTANOOGA, TENN.

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CITY OF PITTSFIELD.

Sewer Construction.

NOTICE TO CONTRACTORS.

Sealed proposals for constructing about seven (7) miles of pipe sewers, in the City of Pittsfield in the Commonwealth of Massachusetts, will be received by the Board of Commissioners of Sewers of said City at their office in said City until 12 (noon) of Saturday, April 15, 1893, when they will be opened and read in the presence of the competitors. All proposals must be on the blank form furnished by said Board, and must be accompanied by a certified check payable to the said City for one thousand dollars. Pipe, brick, cement, iron pipe and iron manhole castings will be furnished by said City. Plans and profiles can be seen, and the specifications and form of contract obtained at the above office, and also at the office of the Engineer, Ernest W. Bowditch, 60 Devonshire Street, Boston, Mass. No bid will be received in case the bidder has not looked the work over on the ground. Said Board reserves the right to reject any and all bids.

JOHN H. MANNING,
CHARLES W. KELLOGG,
JAMES L. BACON,
Board of Commissioners of Sewers of the City of Pittsfield.
ERNEST W. BOWDITCH, Engineer.

13-2t

TO WATER-WORKS CONTRACTORS.

Sealed proposals will be received at the office of the Board of Water Commissioners (2d floor Municipal Building), addressed to the undersigned and indorsed "Proposals for the Construction of Water-Works," up to 6 o'clock p. m. of Tuesday, the 18th day of April, 1893, for the furnishing of all material and the completion of a system of water-works for the municipal corporation of Mahanoy City, Pa.

The work will approximate as follows: Dams, reservoir, pumping engines and about nine miles of cast iron pipe of from 14 ins. to 6 ins. in diameter, 40 fire hydrants, together with all stop gates and other appurtenances. Plans and specifications can be seen at the office of the Engineer, Mahanoy City, after April 1st, 1893.

A certified check in the sum of $500 must accompany each bid.

The board reserve the right to reject any or all bids.

By order of the Board:
FRED MILLER,
EDWARD GORMAN,
RICHARD T. LEWIS,
Water Commissioners.

J. MARSHALL YOUNG,
Easton, Pa., Engineer.

13-2t Mahanoy City, March 24, 1893:

TO IRON AND STEEL STRUCTURE CONTRACTORS.

The "Board for the Improvement of Park Ave. Above 106th St." invites proposals for the construction, manufacture, and erection of a "four-track" elevated viaduct structure, to be constructed on Park Ave., between 110th St. and the Harlem River, in the City of New York, in accordance with specifications, copies of which can now be obtained, and the plans of the work seen on application at the office of the Board, Room No. 4, No. 132 Park Ave.

Proposals will be received at the office of the Board until the hour of 3 o'clock p. m., on Thursday, the 27th day of April, 1893, at which place and hour they will be publicly opened by the President of the Board.

Blank proposal forms and envelopes for inclosure of same, and any further information desired can now be obtained on application at the above-named office.

By order of the Board:
CHARLES W. DAYTON, President.

New York, March 30.

COMMONWEALTH OF MASSACHUSETTS METROPOLITAN SEWERAGE COMMISSIONERS—NOTICE TO CONTRACTORS.

—Sealed bids for the pumping plant for the Metropolitan Sewerage pumping station at East Boston, and sealed bids for the pumping plant for the Metropolitan sewerage station at Deer Island, will be received by the Board of Metropolitan Sewerage Commissioners at its office, 110 Boylston Street, Boston, Mass., until 12 o'clock m. of Saturday, May 27, 1893, and at that time will be publicly opened and read.

The Board will provide at each pumping station, an engine house, boiler house, chimney and masonry foundations for the pumps. The contractor's bid for each plant must be for furnishing, setting up, and completing, ready for use, two pumping engines (or sets of engines), four boilers, piping and all necessary appliances and fittings such as are to be found in pumping stations of the best class.

Each pumping engine must be capable of easily raising 70 cubic feet of sewage per second 19 feet vertically above the level of the sewage in its respective pump-well. Each of the engines must also be capable of raising to greater lifts up to 25 ft. quantities of sewage inversely proportional to such lifts.

Each engine must also be capable of pumping at as low a rate as 15 cubic feet per second, and at all rates between 15 and 70 cubic feet per second.

The foregoing capacities must be demonstrated by suitable trials.

Each bidder must state in his bid the duty he will guarantee for each engine in the duty trial mentioned in the table below:

Table of Some Approximate Working and Trial Data, Etc.

	Deer Island.	East Boston.
Elevation of the surface of the sewage in the pump-well above datum....(Varies from	Feet. 94.0	Feet. 90.8
(to	101.4	93.5
Elevation of the bottom of the pump-well is assumed to be..	85.5	80.0
Elevation of the surface of the sewage in the discharge channel above datum.(Varies from	101.0	105.3
(to	*120.0	112.5
Least lift.....	6.0	14.5
Average lift.....	11.0	15.0
Ordinary maximum lift.....	18.6	19.0
Extreme lift at high spring tide and during rare storms.....	20 to 25	20.0
Lift during duty trial at rate of 70 cu. ft. per sec.....	11.0	15.0
Lift during capacity trial at rate of 70 cu. ft. per sec...	19.0	19.0
The elevation of the boiler house floor should be not lower than.....	116.5	116.5

*This elevation is for mean high tide. During spring tides and storms it will be higher.

The elevations mentioned above are referred to a datum about 100.64 feet below mean low water of Boston Harbor.

The contractors must provide at each station four steam boilers of such capacity that any three of them can easily supply the necessary steam for the two engines when discharging together 140 cubic feet per second with a lift of 19 feet.

Plans will be furnished by the Board showing the position of the engine houses and the in-coming and out-going sewers at East Boston and Deer Island.

The first pumping engine at each station, and at least two boilers at each station, must be set up, ready to run, before May 31, 1894; the remaining engine, boilers and other appliances before Aug. 31, 1894. A third pumping engine and additional boilers will probably be called for at each station within a few months thereafter, and a fourth engine and additional boilers may be needed in the future. The third and fourth engines and their boilers are not now to be bid for. The arrangement of the plant, however, must be such as will not interfere with the above named extension.

The design of the pumping engines may be of any form which will fulfill the required conditions.

Each bid must be accompanied by drawings showing clearly the size and arrangement of the steam cylinders, pumps, boilers and all other parts of the mechanism and must also show the necessary details for the engine foundations, which are to be provided by the Board.

The specifications, which must also accompany the bid, must give the kind and the quality of the materials of which the various parts are to be composed, the size and the strength of the principal working parts, and the manner in which they are to be constructed, so as to furnish a clear understanding of all points regarding the workmanship, strength, durability, general efficiency of and space occupied by the whole mechanism and plant.

Each bid must be inclosed in a sealed envelope indorsed "Proposal for Pumping Plant for the Metropolitan Sewerage Pumping Station at East Boston" or "Proposal for the Pumping Plant for the Metropolitan Sewerage Pumping Station at Deer Island," and be delivered to the Board or to its clerk.

Each bid must be made on one of the blank forms furnished by the Board, and must be accompanied by a properly certified check for the sum of $1,000, the latter to be returned unless forfeited by the abandoning of the proposal.

The Board reserves the right to reject any and all bids.

Plans, blank forms, general specifications and further information may be obtained at this office.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON.
Board of Metropolitan Sewerage Commissioners of Massachusetts.
HOWARD A. CARSON,
Chief Engineer. 13-9t

STREET LIGHTING.

Proposals to light the streets of the Village of Flushing, Queens County, N. Y., will be received by the Board of Trustees of said village at their rooms in the Town Hall until 8 p. m. on the 6th day of June, 1893.

For information and specifications apply to G. A. Roullier, Village Engineer, at No. 20 Main St., Flushing, L. I.

Each bidder will be required to deposit with his proposal or proposals a certified check in the sum of $2,000.

The right is reserved to reject any or all bids.

By order of the Board of Trustees.
CLINTON B. SMITH,
14-3t Clerk.

SEWER CONSTRUCTION.

IRVINGTON, N. Y.

Sealed proposals will be received by the Board of Sewer Commissioners of the Village of Irvington, N. Y., on or before Saturday, the twenty-second day of April, 1893, at 2 p. m., at which time the bids will be publicly opened in the Athenaeum Building on Main St., Irvington, N. Y., for the construction of a portion of the permanent system of sewers, to be built in Irvington, N. Y., according to the plans and specifications prepared by Charles B. Brush, Civil Engineer, and approved by said Board April 1, 1893. Proposals to be sealed and indorsed "Proposal for Sewers," and must be addressed "To the Board of Sewer Commissioners, Irvington-on-the-Hudson, N. Y.," and delivered to Charles Eddison, Clerk of the Board, Irvington, N. Y., on or before that time.

The Commissioners reserve the right to reject any and all bids if deemed by them for the interest of the village so to do. No bid will be accepted unless it is upon the blank form, which has been prepared for, and which will be furnished to, bidders.

Said plans may be seen and examined and printed copies of the specification and blank forms for proposals may be obtained upon application to Commissioner H. H. Cannon, at his office on "A" St., opposite the railroad depot, each week-day, between the hours of 7 a. m. and 6 p. m. until said bids are opened as aforesaid.

By order of the Board:
CARROLL DUNHAM,
CHARLES EDDISON, President.
Clerk.
Irvington, N. Y., April 1, 1893. 14-2t

TO CONTRACTORS FOR ROCK EXCAVATION.

Chicago, March 31, 1893.

I have a contract for the removal of about 70,000 cubic yards of limestone rock from the bed of the Kankakee River at and near Momence, Illinois, and desire to sub-let the same to other parties. If you would like to bid on this work, I would be glad to receive a proposal from you on or before April 15th, 1893. The plans and specifications for this work can be seen at my office, Room 905, 100 Washington Street, Chicago. The money to pay for this work is provided for, and will be paid out by the Commissioners appointed by the State of Indiana on monthly estimates as the work progresses.

CHARLES T. MASON.
Room 905, 100 Washington Street. 14-1t

GREENVILLE, MISS., WATER-WORKS.

Sealed bids will be received at office of City Clerk of Greenville, Washington County, Mississippi, up to noon on Tuesday, May 2d, 1893, for building city water-works under a franchise system. Bidders to furnish plans and specifications. 14-4t

TO CONTRACTORS FOR PIPE LAYING.

Sealed proposals for laying about 16,500 feet of 24-inch cast iron force main, will be received by the Sewerage Commissioners of the City of Brockton, Mass., until 12 o'clock, noon, on Monday, April, 24, 1893, at their office, Home Bank Block, Brockton, Mass.

Each proposal must be made on the blank forms furnished by the Commissioners, and be accompanied by a certified check for the sum of $500.

Forms of contract and specifications can be obtained at the above office.

The Commissioners reserve the right to reject any and all bids.

R. P. KINGMAN,
H. A. MONK,
A. C. THOMPSON,
Sewerage Commissioners.
F. HERBERT SNOW,
City Engineer. 14-2t

SEWERAGE COMMISSIONERS OF THE CITY OF BROCKTON.

NOTICE TO SEWER CONTRACTORS.

Sealed bids for building filter beds, Section 5, of the Brockton sewerage system, in accordance with the form of contract and specifications to be furnished by the Sewerage Commissioners, will be received at their office, Room 27, Home Bank Block, Brockton, Mass., by the said Commissioners, until Thursday, April 20th, at 10 o'clock a. m.

No bid will be received unless accompanied by a certified check for the sum of $500.

All bids must be made upon the blank forms furnished by the Commissioners.

The Engineer's estimate of work is:

3,000 square rods grubbing, clearing, etc.
60,000 cubic yards excavation in beds.
1,000 " " " " brook.
2,000 " " " " underdrains.
3,760 linear ft., laying 24-in. and 20-in. pipe.
2,300 " " 15-in. and 12-in. pipe.
1,975 " " 15-in. and 12-in. underdrains.
42 cubic yards brickwork.
60 " " rubble masonry in outlets.
44 cubic yards rubble masonry in outlet culvert.
20 cubic yards concrete masonry.
200 square yards paving.

Plans can be seen and specifications and forms of contract can be obtained at the above office.

The Commissioners reserve the right to reject any and all bids.

R. P. KINGMAN,
H. A. MONK,
A. C. THOMPSON,
Sewerage Commissioners.
F. HERBERT SNOW,
City Engineer. 14-2t

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UNITED STATES ENGINEER OFFICE, 34 West Congress Street, Detroit, Mich., March 18, 1893.—Sealed proposals for turbine power plant for the 800-ft. lock, St. Mary's Falls Canal, Mich., will be received at this office until 2 p. m. May 2, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. O. M. POE, Colonel Corps of Engineers, Bvt. Brig.-Gen., U. S. A. 12-4t

PROPOSALS FOR CONSTRUCTION OF PILE BULKHEAD IN QUINCY BAY.—U. S. Engineer Office, Rock Island, Ill., March 8, 1893.—Sealed proposals, in duplicate, for construction of a pile bulkhead in Quincy Bay, Illinois, will be received at this office until two o'clock p. m., April 8th, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office, 11-4t

U. S. ENGINEER OFFICE, WILMINGTON, N. C., February 28th, 1893.—Sealed proposals will be received at this office until 11 a. m., Saturday, April 8th, 1893, and then publicly opened, for removing a wreck at the entrance to Cape Fear River, N. C. Specifications, blank forms and all available information will be furnished on application to this office. W. S. STANTON, Major, Corps of Engineers, U. S. A. 11-4t

ATTENTION!

Railroad Contractors!

Sealed proposals will be received by the Elkhart & Western Railroad Company for grading 10 miles of its roadbed. Also proposals will be received for completing the same, all materials being furnished by the railroad company. Bids will be received until April 15. For full particulars address

E. C. BICKEL,
General Manager,
Elkhart, Ind.,
or H. E. BUCKLEN, President,
275 Michigan Ave.,
12-3t Chicago, Ill.

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